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SIR FRANCIS PETTIT SMITH.

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FORTY YEARS is not of much account in general chronology and indeed in the life of man the retrospect is soon examined. Individuals have experienced the alternations of joy and sorrow, have had their regrets and their causes for thankfulness; and they have a remembrance more or less vivid of events distinguished by the griefs they have produced, or redolent with a pleasure whose charm is not yet lost. But forty years in our time has been sufficient to witness the transformation of many of the chief departments of scientific knowledge; or if not the transformation of old ideas, those latest have been forced forward in a way that puts all previous practice entirely aside. Chemistry, steam, telegraphy, mechanism have in relation to what they represented in 1837 opened new avenues of light, thought, and riches, to the enjoyment, as also to the astonishment, of mankind.

The career of Sir Francis Pettit Smith is a scientific biography such as is common to the majority of scientific men. Adventitious circumstances seldom throw around them a halo of splendour, or afford them ordinary protection. The course of their lives would seem to be a matter of instinct rather than one of selection. Ideas are followed as they are generated, with affection and zeal: energy is created by circumstances, and it does not diminish by exercise or opposition. On the contrary, it grows from both those causes, and from the humblest ranks we find these devotees of truth absorb knowledge, acquire power, and do works which they themselves are scarcely conscious of. To their own amazement there comes from them some brilliant discovery, or the announcement of some new truth, either speculative or practical, either moral or philosophical, but all tending to bring into human hands and minds the government of things that surround us and act upon us.

The ancient borough of Hythe, one of the Cinque ports, claims the distinction of being the birthplace of Sir F. P. Smith, whose father was postmaster there at the beginning of this century. The date of his birth was Feb. 9, 1808. The education he received by tutors and books appears to have been of the most scattered and indefinite nature, and after picking up what could be assimilated from the common school-life at Ashford in Kent, he entered upon the business of manly existence as a grazing-farmer at Hendon, Middlesex, but with a strong predilection for mechanics, especially in connection with boats.

In the writer's recollection the name of John Bourne of the "Artisan," occupies the position of a friend and teacher. He wrote a Treatise on the Screw Propeller, and from that great work of his we extract what he says of F. P. Smith in 1851:

"With these remarks I conclude this chapter on the practical introduction of the screw as a propellor; and while I am quite sensible of its many deficiencies, I believe that it will be recognised by the engineering community as an accurate statement of the facts of the case, and as a just reward of the merit pertaining to particular inventors. To engineers it has long been known that F. P. Smith has been the author and establisher of the art of screw propulsion—at all events in this country: and engineers are certainly as well qualified to form a just opinion on this subject as any other class of the community, and have as little temptation to strain their real convictions. Other screw patentees there are who, like Indian mercenaries, have lain by until the battle was fought by Smith and Ericsson, and have then come forward to claim the fruits of victory; and courts of law, bewildered by questions they did not understand, have permitted claims to be entertained, which ought to have been at once disallowed. But whatever decrees may be elsewhere pronounced, the judgment of the public is pronounced already, and will be ratified by posterity. And when the people of future times inquire, in what way, or, by whose instrumentality the art of propelling vessels by a screw was first established, they will learn that this important amelioration was accomplished, not by any eminent engineer or learned academician, but by a farmer at Hendon, called, like another Cincinnatus, from the plough, to advance the interests of his country. Against that time, other names, at present far more imposing, will have faded from the recollection of mankind; but the name of the originator of a new art lives as long as the art itself, and gathers new lustre by the lapse of years."

Bourne has many a time done services to England at home and abroad, but the eloquent passage just quoted is as fine a specimen of English as it is a faithful reflex of the English heart. When it was uttered it had a special significance, and it rang through the list of detractors, conveying caution and rebuke from one who is, without exception, the complete master of all knowledge appertaining to the employment of steam.

We hope at an early date to record the work Ericsson performed in the service of practical science; but meanwhile it is good to note that in connection with F. P. Smith the name of John Ericsson is perpetually connected in the invention and adoption of the screw-propeller, and it is right to say that while rendering to Smith and to Ericsson the honour to which they are entitled, it would be unfair to pass over, without acknowledgment, the services of those who were their coadjutors in that important work, or by whom their progress was assisted. Men of science cannot effect any service without the aid of men of capital. The auxiliary in this case must be named: Mr. Wright, the banker, had the pleasure and had the honour of enabling Mr. Smith to take out his patent, and a quaint patent it is:

"A.D. 1836, May 31.—No. 7104.—To all to whom these presents shall come, I, Francis Pettit Smith, of Hendon, in the County of Middlesex, farmer, send greeting . . . I do declare the nature of my said Invention to be a sort of screw or worm made to revolve rapidly under water in a recess or open space formed in that part of the after part of the vessel commonly called the dead rising or dead wood of the run." It is described by Mr. Woodcroft in his excellent abridgments of patents as "a horizontal axis carried a broad-threaded revolving screw, the axis of which is supported on plummer blocks at each end, and turned by a crown-wheel on an upright shaft, in a water-tight case." The screw had two turns of the thread, but by a memorandum of alteration in 1839, he put a screw with one turn of the thread, and another shaft with *two screws* upon it, the threads of which begin from opposite ends, of the same diameter, and continue (each of them) one half-turn.

Smith therefore owed to Mr. Wright the power of bringing out his invention; but it is good to know that when the man of science and the man of capital meet, and the invention is produced, the engineer must be found who will be willing to provide an opportunity of putting the whole to a practical test. The Messrs. Rennie, whose name will always be honoured where skill and integrity are recognised, undertook the experiment. They saw its merit and staked their money in proof of their confidence in the result of the idea. A screw propelling company was forthwith established, and the first operation was the construction of the famous "Archimedes." There cannot be a question that the first steam-ship, ever propelled by a submerged screw was the "Archimedes," nor can it be gainsayed that F. P. Smith was the adapter of the principle successfully. For many years he had devoted all his leisure and much of his time in furtherance of the plan: and he also used all the money he made at farming to carry it out. He succeeded. The navies of Great Britain and of France can testify to that. He was blest by seeing his darling plan, modified of course according to circumstances, adopted everywhere. Sir J. K. Brunel recommended it to be adopted in the "Great Britain" instead of paddles, which had been originally intended; and as Mr Bourne justly observes, engineers saw and felt that a new and mighty power had been revealed. The Board of Trade returns for 1857 shows what had been done, and what was coming, through Mr. Smith's invention. There were 820 wooden steam vessels afloat with paddle wheels, and 19 only had the screw propeller: but of iron vessels there were 356 with paddle-wheels, and 473 with screw propellers. In the navy were 67 wooden steamers with paddle wheels, and 160 with screw-propellers.

Such a revolution in steam navigation elicited approval from the public, the press and parliament, and compelled a reluctant government to bestow honour and reward, but not without great efforts from the unofficial world. With unceasing energy Smith had devoted the best years of his life to the purpose of establishing the merits of the screw from the period of his successful trials and voyages of the "Archimedes" in 1839 and 1840, and by the aid of the screw, distances can now be measured by time. In times of peace this would be a most valuable power; but much more so in times of war, when the lives of thousands are involved in the expedition of our transports. By the aid of the screw our naval armaments have assumed a power that at one time could scarcely be contemplated; the screw sets at defiance the danger of a lee shore, can encounter an enemy without waiting for a favourable wind, and is no longer detained by necessity in distant ports when its presence is required elsewhere. By the aid of the screw, merchant vessels can now calculate upon their runs with certainty, and whenever a gale or calm threatens the mariner, he has only to get the steam up, let down the screw, and he can defy dangers that would some years ago have appeared impossible to surmount.

In common with most great improvements, such for instance as Watt's relation to the steam engine, no one can lay absolute

claim to the invention, because, in a crude or elementary form, the ideas of both existed hundreds of years ago. He is the practical inventor who, by ingenuity and perseverance, makes ideas that were, before his labours, vague and unfruitful, available for the uses of life. The art of screw propulsion is one of the most important discoveries which science has given to mankind.

Smith had enterprising friends when he proposed to build the "Archimedes,"—it was but a little craft, only 230 or 240 tons. Her performance on trial trips led the proprietors to place the vessel at Captain Chappell's disposal, in order that she might circumnavigate Great Britain, and visit the principal ports on her route, to be inspected by competent judges in the various professions connected with steam navigation. The voyage occupied seven weeks. Leaving the Nore on the 17th May, 1840, for Portsmouth, with stiff head wind and rough sea and bad tide, the steam only took her to Portsmouth, a distance of 165 miles, and done in 22 hours. From Portsmouth is 15 miles, and that consumed two hours also with steam power. In the return journey sails only were employed, and the same time required. From Portsmouth, 130 miles, both sails and steam were employed, and it took 16 hours to reach Plymouth; and then from place to place, Falmouth, Bristol, Tenby, Pembroke Dock, Liverpool, Isle of Man, Greenock, Campbelltown, Fort William, Caledonian Canal, Inverness, Aberdeen, Leith, Tynemouth, Hull, and London were visited, and they arrived on the 7th of July, having traversed more than 2000 nautical miles in 237½ hours, experiencing all sorts of weather.

The rapid strides which the system made in the space of two years, before which it was universally unpopular, evidenced its importance. Vessels such as the "Great Britain," with 1000 horse power engine, or one in Londonderry of 1500 tons burthen, and half-a-dozen more of the same character, were constructed on this principle, and successfully competed with all the rivals.

Public feeling in regard to Mr. Smith's reward reached a climax when the splendid review took place at Spithead in 1856, and in Parliament many strong remonstrances, not unmingled with indignation, were uttered, because of the contemptuous neglect or dishonourable indifference of the Government in reference to his claims. Her Majesty granted him a pension of £200 a year, and soon afterwards the leading engineers of the country made a subscription, and provided him with a service of plate, and the sum of £2,678, as a testimonial. It was calculated that up to 1856 the English navy alone had saved engines to the extent of above 100,000 horse power, the cost of which, not including the hulls, would be between five and six millions sterling; it is quite impossible to estimate the services rendered to merchant vessels, long voyages, foreign shipping, and foreign navies in all parts of the globe, besides having led indirectly to many other improvements, and also to its own perfection.

In the Great Exhibition of 1851 Mr. Smith exhibited the screw and its improvements to that time, and they relate the history of the invention without the aid of words: 1. A screw of the entire turns of a single thread, as applied to his working model in 1835; and, subsequently, to an experimental boat of 6-horse power in 1836. 2. A screw of one entire turn of a single thread, as applied to the same boat, and subsequently to the "Archimedes," a vessel of 237 tons, and 80 horse power, in 1838. 3. A screw of two half turns of a double thread, as applied to the "Archimedes" in 1839, and, subsequently to the "Princess Royal," of 50 horse power, in 1841; the "Great Northern," of 4515 tons, and 360 horse power, in 1842; and H.M.S. "Rattler," of 888 tons, and 200 horse power, in 1843. 4. The same screw reduced to two quarter turns of a double thread, and tried experimentally in H.M.S. "Rattler," in 1844. 5. The same screw reduced to two one sixth parts of a turn, as tried in H.M.S. "Rattler" in the same year; H.M. steam-yacht "Fairy," in 1845; and which in 1852 was applied to upwards of 40 ships in the British navy, of all classes, up to 80 guns; and very generally 200 vessels in the merchant service. The same screw was further reduced to two one-eighths of a turn. 6. The actual propeller used by Mr. Smith in his experimental boat of 6 horse power in 1836-7 on the Paddington Canal, and with which she performed the *first sea trip* ever made with a screw propeller. 7. The original screw, two inches in diameter, made by Mr. Smith, and applied to his working model boat in 1835. 8. An original working model of the "Archimedes," with a screw of one entire turn. 9. Two models, showing the manner in which 1, 2, 3, 4, and 5 were made, in sections or portions of the screw, each section being half an inch in length, or one 48th part of the pitch. 10. Fac-simile of a model of the screw-propeller of H.M. steam-yacht "Fairy," presented by Mr. F. P. Smith to Her Most Gracious Majesty Queen Victoria, on board the "Great Britain" steam-ship at Blackwall, on the 22d of April, 1845.

Mr. Smith retired from the manufacture of screw propellers in 1850, after a life of great service and honour. The Government bought up his patent rights for £20,000, after he had been the means of saving them an outlay of a million, and made the fortunes of a hundred men. At the age of 63, twenty years after these labours had ended, the honour of knighthood was conferred upon him, and after wearing that distinction for three years, Sir Francis Pettit Smith departed this life, amid the regrets of the public and his scientific brethren.

W. S. C.

WARMING AND VENTILATING.

WHETHER it will ever be accomplished or remain in the changing uncertainty that especially clings to the subject, Warming and Ventilating will not cease to excite the enterprise of architects, and draw forth the deductions of science. It comes home to every human habitation, and comes as its chief vexation. The size, the aspect, the shape of rooms, the passages, the doors and windows, and their relative position, all add to the difficulty of laying down positive instructions, especially when we find the variations of temperament as well as temperature of the human body, making a law for one that another could not accept. There are special facts and there are special inferences of a somewhat positive character, and as we can only learn upon the basis of some knowledge experimental or derived, we must possess an acquaintance with the general facts, and draw therefrom such inferences as shall lead to practical experiments of a successful kind. Increased intelligence, combined with observation, will expand the mind, and perhaps lead it to attack the right vein and obtain the hidden treasure.

We have read with much interest Captain Douglas Galton's paper, read at the recent Birmingham Congress. It is too long; it contains a mass of facts that must have been known to every adult in that intelligent assembly; but from it we can gather much instruction, especially in the light of recent scientific efforts and inquiries of a more practical character.

Canada had, and we hope still possesses, an indefatigable and shrewd authority on Warming and Ventilation in the person of the Hon. Henry Ruttun, and many of his suggestions have so been popularized that we can scarcely believe ever that to Canada we owe so much of knowledge on a subject of great moment to us, but with their colder seasons of immense value to them. Warm air is readily susceptible of becoming impure, and the outer air is often charged with poisonous germs: the conditions of life require that the human frame be not exposed to violent contrasts of heat and cold, or of moist or dry atmospheres; and he who should be able to put young builders, of whom our age has a vast number, upon the right track, whereby rich and poor may avail themselves of the inestimable advantage of pure air within their dwellings, instead of the foul that now infests them, will indeed be a benefactor. It surely ought to come by a little train-work in architect and builder.

In our last we referred to an excellent series of illustrations intimately connected with this subject; indeed, the subject is the same: but the increasing interest attached thereto in the public mind calls for other remarks independent of those referred to. "Ventilation should determine the *site* on which a dwelling is placed, as well as its *form*. A failure to remember this causes an absolute contrast in the comfort of two houses built on one plan, if their aspect is different. The one will be extremely cold, so cold that it can only be heated or protected by great efforts, and the other will have the air of another climate.

How to regulate the warmth of the air we admit from outside is therefore a subject demanding a knowledge of the various circumstances of dwellings, and a tact that shall guide to right methods.

The uniform temperature of the organs is an essential condition of man's life. The torrid zone and the arctic make no difference in the animal heat which is 99½ Fahr. If difference is produced, injury ensues and death. Heat of the body is continually being lost by our going into cold places, or exposure to draughts, or by insufficient food and exercise. In houses the air is enclosed in confined spaces, by which it becomes saturated with impurities until it is too heavy to move, and is stagnant. Our houses should admit of a free circulation of pure air at a tolerably equal temperature; in so far as that is effected they are healthy dwellings, but not otherwise. A human being produces enough of waste and poison to destroy itself in a very short time, and there must be devised an artificial circulation of external air at a warm temperature.

The human being requires 200 ft. of air in every hour, merely to dilute the carbonic acid and water expelled from his body to the atmospheric standard. In addition to this his skin and lungs continually throw off offensive poisons, which can only be dispersed properly by ventilation. The air of a room would have to be changed four or five times a minute to keep it to the standard quality of the external air, and that remedy would be no improvement on the nuisance. The indoor atmosphere must be artificial, it cannot be absolutely natural. The test of how far impurity can be permitted may be safely left to the sense of smelling, if that sense is properly respected; it will test the excessive exhalations better than any pneumatic machinery—in fact it is the only test. Sleeping rooms, living rooms, sick rooms, and hospitals, have all different vitiations of the atmosphere, and have to be treated respectively according to circumstances. The general law is that every individual requires 3000 cubic feet an hour of fresh air to preserve the requisite degree consistent with health, but in practice it is found that 1,200 cubic feet will suffice to maintain a fair condition, because allowance has to be made for doors, windows, and the varying absorbency of building materials, and also the position of the rooms, whether internal, or having an external side.

There is a popular regard for large rooms, and it is in many respects much to be desired that there should be space. Comfort, ornament, ease, and general arrangements are best aided by spacious rather than contracted apartments; but it must be borne in mind, that the size of an occupied and ventilated room only attests the purity of the air by making a difference in the time when standard vitiation is reached, and by making it more easy to supply fresh air without producing sharp currents or sudden chills. The degree of impurity does not depend on the size of the room, but upon the rate of foulness as it is produced, and the rate of replacement by fresh air. Floor space is of more value in the arrangements of sleeping rooms than cubic space. You might put beds close together in a room 12 or even 10 feet high and acquire the cubic space but the exhalations that are deleterious cannot rise, and all the top may be pure, and the air around the bed very poisonous.

Many contrivances have been made with a view of regulating this condition: if air can be forced into a room one would suppose the foul would be driven out; but in practice it is not so: and some have the idea of drawing the foul air out by pumping, but it is not of much actual value. The best remedy is found in warming. The temperature of the British Islands is as changeable and varied as that of any known part of the earth's surface, and that brings relief and sometimes something else. The sun's influence again is of the same character: every form of light, shine, shade, darkness, and twilight, is familiar to us more than to any nation, and each act upon the atmosphere, producing changes that to a great extent maintain average public health. Mechanical methods, such as contrivances for currents, or cold, or heat, are not much sought after by the healthy, for they do not require them. But as half the world is under age, and a large proportion of the rest liable to suffer from atmospheric changes, or by defective domestic arrangements, we that are strong must bear the infirmities of the weak, and not please ourselves.

As the air of a room is warmed by the occupants, it ascends, comes against the glass, cools, and falls. Draughts near a window are nothing more than the result of this cooling process. This hot and cold antagonism causes winds and hurricanes, as well as incommodes our dwellings, except we can have mechanical appliances. The air inside a close hot room cannot be still: it cannot get out, because the outer air is cold and the height of the room is not sufficient to create a draught to the top, of sufficient strength to produce a healthful current. It would require 30 or 40 feet, and then the building must be artificially charged with warm air. This we attempt to do with our chimneys: and in reference to that portion of the subject we must refer to our last number, wherein the best modern examples are described and the reasons given.

Warming and Ventilating acquire an additional consequence from the migratory habits of the people. A family who have been accustomed to endure a British winter with submission and comfort, would break down if called to undergo such a season in St. Petersburg or in our Canadian Dominion. But as none of us can possibly assert that by no possibility we can ever be called upon to leave England, it becomes us to be prepared for that as for any other emergency, so far as to know what is wanted if such a change occurs. In England we want a change of air except in very bitter weather; but in cold climates it is not only a change that should be secured, we should want to ensure warmth at an equalized temperature.

Having already treated of the management of heating ordinary rooms, we take the larger question—how to warm large spaces, which in Canada and in the States is a serious business; in intensely cold weather such spaces become intensely cold, and could not be warmed by any quantity of fire in our ordinary chimney place. Ruttun contends that the source of heat in such a case should be at the top, and that if forced in it will immediately and without mixing with the surrounding air, seek the zone or stratum nearest its own temperature, and thence spread through the entire mass, but it is not correct to have an aperture to let out as well as one to admit cold or warm air, because what comes in will instantly seek the aperture its own outflow, and the body of air remains unmoved. This is an idea that is not usually accepted, but it is the result of experience.

The air in the room is cold—nothing else; which is the best? To warm the air where it is, or get rid of it, and replace it by other air that has been warmed? All our old methods went upon the idea that the air of the room was to be heated (we speak of large rooms or spaces, public buildings; the stoves mentioned in last month's *Practical Magazine* are the most economical for single rooms), but it is pretty clear now that the warming of several rooms from one source, must be achieved by substituting other and warmer air. Thirty or forty years ago, Dr. Arnett endeavoured by his stove to warm shops and public buildings from one of his stoves in the basement. The room occupied by the stove was unbearable, and the other rooms scarcely changed their temperature. His experience is that of others. Heat can be generated easily enough; but how to diffuse it causes embarrassment. It is impossible to reach a higher temperature than 45 degrees unless circulation is increased. To do that some contend that the air must be drawn entirely *outside of the house*, and that that only is a ventilating process.

After the air has received its load of heat from the warming machine, it must be directed by mechanical means, not pipes or conductors, but only by the force of the vacuum created within such apartment by the exit of so much of its air up the shaft as is drawn in from the air-warmer. The aperture admitting the warm air should be near the ceiling, and the motion of the air quick, or the walls will rob it of its warming substance. The air-warmer for a house 40 feet square should send in a body at 90 or 100 degrees on an ordinary winter's day, and that will send air out at the bottom at about 60 degrees. Some of our air-furnaces are at 500 degrees, and then do not warm the air.

The proper and most economical shape of the metal of an air-warmer, is that which presents the greatest surface to the centre of the fire; and that of course is globular. Where wood-fuel is used that shape is inconvenient, and then the two sides of the air-warmer rise perpendicularly high enough, and gradually approach each other towards the top, which plan preserves the globular form as nearly as the case will permit. The surface, inside and outside, should be *plain*. Indentations or ornaments tend to throw the rays of heat out of their order, and hinder their operation.

It only requires a cursory view of our hot-air furnaces, with bulb upon bulb, pipe upon pipe, laid horizontally perhaps, to see their defects. The only rapid current of air within their hot chambers is around the outside of the furnace, touching merely the edge of the bulbs, and so passing off. The inmates of a house so treated thus violently, perhaps by hundreds of degrees, do not see that air, having been once rendered unfit for breathing by heat, cannot be restored by mere cooling.

Mr. Ruttun says, "I admit of no hot or warm-air chamber except in the building itself. The air-warmer, whether placed in the basement or in the hall, or any other convenient place, should never be so cooled as to admit of being closed, except to regulate the quantity of cold air, when there is a fire in it. If set in the basement, all the warm air they manufacture should at once be let into the building, through a register which will freely pass the whole quantity and fill the house, each apartment drawing on the whole body of air according to its requirements.

Suppose that there are two rooms, one above the other, and that the lower room is filled with cold and the other with warm water. If an aperture is made *between* them, neither will change their temperature, because cold water is heavier than warm. This is the case with air; the cold is at the bottom, because it is the heaviest. If you pierce the floor of the cold-water room, and let its contents run away, the warm water from above will occupy its place. So with air. The cold must first run out, drawing the warm after it.

In referring to Captain Galton's paper in favourable terms, we must not be supposed to accept his conclusions. Those above recited seem to be much more consistent with the ordinary laws, so far as we are able to comprehend them. Admitting a current of cold air, for instance, at the back of a chimney will of course produce a sharp draught, and make the fire in the open grate burn bravely, but all the heat must go up the chimney, except what may be felt from the glow of the burning coal as one sits round the fire. It has the advantage, truly, of checking the force of house draughts, but the principle does not com-

mend itself with half the force of that above recited. And this kind of remark would be repeated concerning most of the other suggestions; they collect ideas that are popular but not necessarily sound. They are, in fact, unsound, if such a word may be employed.

The list of inventions and contrivances that have been patented is long enough and sufficiently puzzling to prevent minute examination; but what shall be said of the hundreds of private suggestions made by architects, builders, and proprietors, who, having a whim they did not care to patent, found a way for its indulgence in the ordinary course of their lives. These unknown ideas contain, without question, the whole range of practical science, in respect of warming and ventilation, and by-and-by will come to the front as patents or discoveries. Meanwhile, the Canadian engineer has spoken more original thought than any other, and if it be said the style of his communication has not the finish of a teacher, there is enough in it to make the reader think—a quality not inherent to every book or pamphlet.

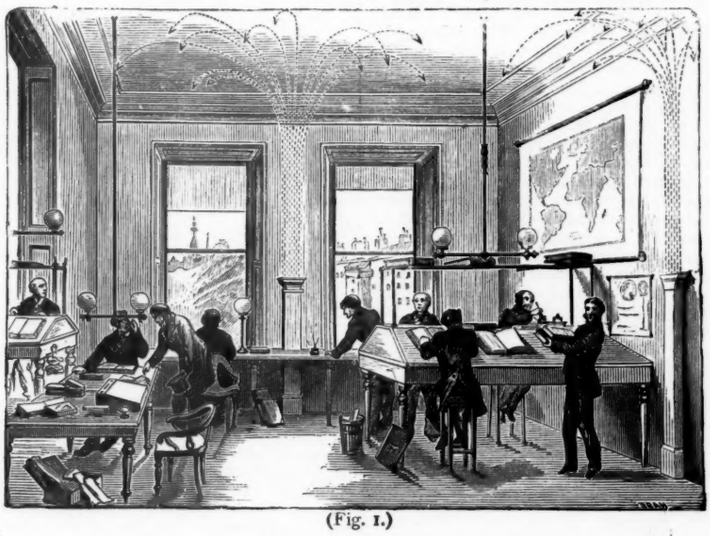
In ancient days these notions were familiar. We desire to purify our atmosphere, and they felt the importance of doing likewise; with this difference, that they, being in a hot climate they sought to cool what we, in winter, desire to warm. But they did it from the top. The operation was simplicity itself. It consisted of a frame erected at the top of the house, enclosed or covered on all sides, except at the mouths, which were open to the prevailing wind; the roof sloped down from each open end to the centre, where a partition divided it, and deflected the wind into the apartments below; the heavier atmosphere permeated the lighter, and drove it out as impure into a duct beneath the floor, just as this Canadian would force hot air into the top and leave no place for the escape of the impure or cold but a duct below. John Evelyn, the learned author of "Sylva," and the celebrated diarist of the time of the Charles's, recognises the principle of the common air being the only invigorator of life, in his directions for conservatory erections. The earthen pipes were to come through the stove, which must be outside the house, and were laid so as to form a hearth; thus the common air could not pass without it were warmed, and it was welcome to admission when prepared; an air-pipe was added, which brought back the consumed air into the external shaft.

Ventilation and warming demand yet further efforts of our engineers, and those who are looking for a special subject on which to exercise their faculties and concentrate their scientific effort, would do well to give this a careful consideration. We will say what has been done; any one can find out that much remains to be done. What that future may be is not within our scope of forecast.

Dr. Reid's work on the Houses of Parliament has now faded from the general knowledge, and as he was superseded in a few years subsequent to his appointment, the probability is that it was an unsatisfactory transaction. Of that, indeed, there can be no doubt. His plan will not bear examination in theory, and it is exploded in practice. "In the most important public buildings of the metropolis, such as the Houses of Parliament and the British Museum, it has been necessary to wash the air before it could be allowed free ingress, and the arrangements for this washing have been such as to neutralize the external pressure, and to require an elaborate and very expensive system of fans, exhausts, and other mechanical appliances, for the purpose of driving the washed air to the apartments in which it was required."

In the case of the Houses of Parliament this failure scheme cost more than £50,000. The air is drawn from the top of the Clock Tower, but why the top air in a smoky region is better than the bottom as to quality never appeared reasonable; in fact, considering all the circumstances, and all the chimneys, perhaps a lower level would have supplied a purer. But Reid had his discharge, with a compensation of £3000 for loss of situation, and it looks as if that award were a cheap deliverance.

In the case of the British Museum, his system was practically



(Fig. 1.)

adopted—with what result those who know its workings are best able to judge. We say it is a complete failure. Wrong in principle, costly in construction, expensive in administration, and unsatisfactory in result, it is a caution to all institutions in this and any other kingdom.

But in dismissing Dr. Reid and his work, and in the spirit with which Parliament discarded him, a great deal is to be said in favour of the vertical system, and there is one company that alleges itself to be the possessor of an improved system of Vertical Tube Ventilation, the most perfect and least costly, and makes a workshop pure as to atmosphere, and happy in its occupants by providing cleansed air when the outer source is bad, without causing draughts or permitting the ingress of any particle of dust or carbon to enter, which can, in addition, be separately applied to any apartment. If cleansed or washed air can be supplied to every room in any quantity that may be desired, a marvel of healthful conditions is within our grasp. We can breathe freely because conscious of safety, and that, despite even disadvantage, tends to preserve health. The principle of vertically-ascending self-sustained currents is one that commends itself to all who have observed phenomenal ventilation. The drawing (Fig. 2) illustrates the principle on which these foreign and injurious matters are arrested previous to their entrance through the tube, and also that fresh air enters through an opening in the wall near the floor level, and by means of the vertical tubes just described takes an upward direction. The natural pressure causes in-

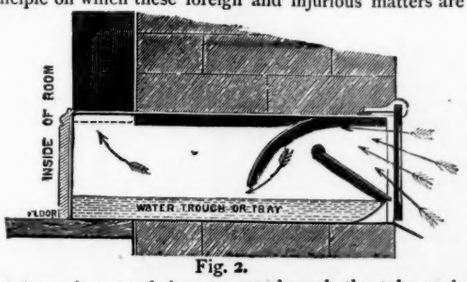


Fig. 2.

creased velocity, especially through a narrow opening, thereby making a direct column of air, which, spreading over the upper part of the room, acquires heat, and then gradually descends to make way for fresh supplies, and passes up the chimney, or down by outlets provided. (Fig. 3 and 4.) The room is of high temperature,

Fig. 3.

Fig. 4.

and therefore the pressure of the column of air diminishing is, before it reaches the ceiling, diminished, and, in fact, neutralised. A most simple arrangement, entirely in accord with the doctrine laid down by our Canadian friend, to whom reference is made in the beginning of this paper.

There is no doubt expressed, and it would be very difficult to accept one even for discussion, that the Sanitary Engineering and Ventilation Company of Victoria Street, Westminster, are pursuing the soundest system of ventilation; and in their system it should be remembered the work is done at the smallest possible cost. In fact, any one can do it now the method is made familiar. They claim and possess this last improvement, and they publish it for the public good.

A most useful and ingenious invention obtained a patent in 1852—consisting of an apparatus to be used through the ceiling or roof of house, or ship, of a building or apartment that led from the interior into the open air. Conical in its lower part, it had a grating over it, or was open; the upper part consisted of a cylinder surmounted by a conical hood affixed by stays, ornamented in detail or left bare; inside is a vertical partition, and at the lower part a horizontal one, having two valvular openings, which, by cords, chains, or pulleys, may be opened at any convenient position of the building. This is known by the name of "Watson's Patent," and is illustrated (Fig. 5) from

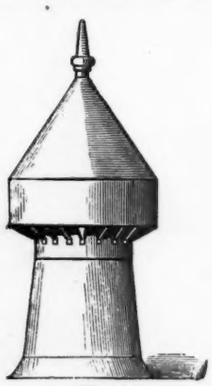


Fig. 5.

the manufactory of Mr Watson's successors, Messrs Hills & Hay of Halifax. This, for churches, halls, and public assembly rooms, excelled all others, as it was the fruit of previous ideas. But in 1843, Mr. W. Watson patented what is fitly described as an improvement in ventilation, which, instead of applying air for ventilation from the level of the building, procured it from an elevation by means of a shaft-pipe, or tubular column, which air may be drawn down the pipe by a fan or other means, and distributed by pipes in the usual way.

This original idea, as is seen, differs from that above described in this respect. By having a partition, one current of air will naturally come down, and the other up. The down draught, which is so noisome, is thus made to consume itself and return to scatter itself into the upper atmosphere.

But in passing, let a note be taken about one, Adam Walker, who, in 1786, invented a stove for purifying or renovating air; it consisted of an ordinary stove, with a retort vessel or bellied pipe, made of pipe or other clay, pottery, glass, or other kind of earthy composition, or materials capable of standing fire or heat, open at both ends, and capable of containing specified quantities of ingredients, such as nitre, minium, clay, potsherds, or any others that produce dephlogisticated air.

Cleansing the air is also effected by the use of a filtering material placed in the tube itself, from whence it can be taken out and cleaned in a few seconds. The peculiar advantage of this arrangement consists in the provision of 700 or 800 superficial inches of filtering area. So large a surface cannot get blocked up, nor does it require the frequent attention that cannot be dispensed with in the other cases. This in passing: it is knowledge.

Mr Watson wrought wonders, as has been already stated, but his successors have exceeded him. Messrs Hill & Hay assert, what is corroborated by some scores of high-class testimonials, that their Excelsior Syphon ventilator secures these desirable advantages; it is constructed on the syphon principle, for the admission and withdrawal of air at the *highest point* of a room; and the tendency of wind to increase *the force of the air admitted* is reduced to a minimum, whilst the arrangement for the outlet of vitiated air is made certain and steady, thus rendering

Fig. 6.

its action automatic. It possesses the greatest security against the admission of dust, blacks, or wet, and has no mechanical motion. It is suitable for churches, chapels, schoolrooms, public halls, staircases of residences, kitchens, laundries, stables, workrooms, factories, and shed factories, top rooms of mills, drying-rooms, paper-mills, &c., &c. For the withdrawal of steam it is considered invaluable, as it does not throw down large volumes of cold air like other ventilators to condense and cool the steam before it can escape.

The new patent Excelsior Syphon Ventilator is so arranged and constructed in its upper part, exposed above the roof, that the force of wind, in increasing the strength of the down current, is reduced to a minimum, without interfering with the free action of the Ventilator, and thus the action of the Ventilator *adjusts itself automatically to the demand*, without causing inconvenience from draught, and while the air is continually being changed and kept pure, temperature is not unduly reduced.

The action of this Ventilator is *more certain and steady than any other, under all circumstances.* The *direction* of the wind has no effect to hinder its action. There is *no opening at the bottom* of the cowl or head as hitherto, and it is not necessary that it should stand so much above the roof. The *foul air escapes at a much higher level, and above the fresh air or inlet openings*, and it *can escape on any or all sides at once.* The Ventilator is thus a *true syphon.*

It is pronounced, as soon as seen, the most perfect Vertical Syphon, or other Ventilator, yet offered to the public, and ha

the *greatest security against the admission of dust, wet,* &c., without *being stopped up* by deflecting plates, perforated zinc, or wire gauze, &c. ; and there are *no moving parts* except the regulating valves, consequently no wear and tear and getting out of order. Sections are supplied where necessary—showing the arrangements, and that is added in Fig. 7.

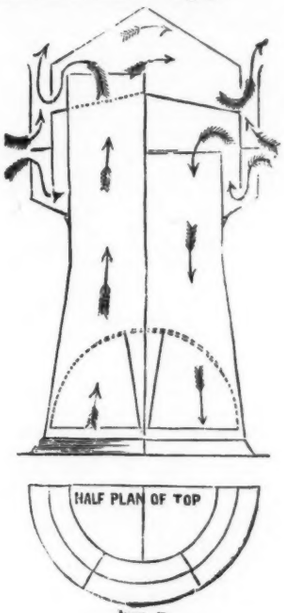


Fig. 7.

The course of the currents and the natural result we plainly and forcibly illustrate thereby.

The Excelsior System Ventilator of Messrs. Hill & Hay is very different from that of their predecessor, Mr. Watson, and the difference appears in the section above presented. It is correctly named Syphon, for that is the principle on which it is constructed. Strong down draughts are prevented, as we have already shown, by the wind when pressed downwards being driven to escape between the chambers and shaft, instead of being forced downwards. It will also be seen that foreign substances, dust blacks, are more certainly excluded in this construction than in Mr Watson's, besides which there is a section pipe fitted to afford perfect protection. Experience disclosed a defect in Mr. Watson's ventilator in a singular manner. When rough winds prevailed the apparatus neutralized itself, because the inlet and outlet were on one level ; the diaphragm in the hand caught and carried down the force of the wind a considerable distance. There is a great variety in ornamental patterns, but the principle is the same.

We omit to notice the ordinary ventilators, for the public is familiar with such as Shirrrington and the others that need no description.

INDUSTRIAL CHEMISTRY.

By Professor Abel, F.R.S.

THIS distinguished chemist occupied the chair at the recent meeting of the Chemical Section of the British Association, and delivered an interesting and instructive address, reverting in terms of eulogy to his predecessor, Mr. Perkin, well known to chemists as the introducer of analine dyes some twenty years ago. As many fresh illustrations, tending to magnify the importance of that branch of investigation and applied chemistry have been made in the interim, he deemed it a topic deserving of an interest bordering on enthusiasm, for the advantages accruing to communities from the promotion of scientific training and the encouragement of chemical research.

The iron and steel industries present a great contrast to that of the artificial colours in regard to the extent of influence which the labours of purely scientific investigation have exerted upon its development. The efforts of scientific men to unravel such problems as the true chemical constitution of steel, or the precise differences between the various combinations known as cast-iron, and the conditions which determine their individual production, or conversion of one to another, have hitherto been attended by results not at all proportionate to the patient investigation of which they have been the subject. The protracted experiments and discussion carried on by Frémy and Caron some years ago on the dependence of steel characteristics on the existence in it of nitrogen, led to no result more conclusive or definite as to the composition, production, and properties of steel, than had been reached by previous eminent investigators. The like may be said of the cast-iron experiments made by Matthiessen and himself under the auspices of the Association to eliminate many points of doubt respecting the constitution of cast-iron, by preparing chemically pure iron, and studying its combination with carbon and other elements of cast-iron.

But while the prosecution of purely scientific investigations may fail to bring direct fruit in regard to new metallurgic achievements, or the elucidation of the complicated reactions which occur in furnace operations, there can be no question that important benefits have accrued from the application of chemical knowledge to the study and perfection of furnace operations, by those who combine knowledge and practice. In the hands of such men, the scientific results arrived at by Karston, Bunsen, Percy, and others, acquire new value, and their labours meet with appreciation, which even solid and permanently valuable work does not always command at the hands of those who follow the more attractive paths of organic research. This, and the general ease with which new results are obtained by the pursuit of methods of research comparatively simple in their nature and few in kind, have for many years not only secured to organic chemistry an overwhelming majority of workers ; they also appear to have a tendency to lead the younger labourers in the field of organic research to under-estimate the value and importance, in reference to the advancement of science, of the labours of the plodding investigator of analysis. Yet no higher example can be furnished of the patient pursuit of scientific work, purely for its own sake, than that of the deviser or improver of analytical processes, who, undeterred by failure upon failure, indefatigably pursues his laborious work, probing to its foundation each possible source of error, carefully comparing the results he obtains with those furnished by other methods of analysis, and patiently accumulating experimental data till they suffice fully to establish the value and trustworthiness of the process which he then publishes for the benefit of his fellow-workers in science. Truly, the results of such labours do not stand in unfavourable contrast, from whatever light they may be viewed, to those of the investigator of organic chemistry. It is not to be denied that the labourer at organic research may, so far as the analytical work which should fall to his share in the course of his investigations is concerned, be tempted to reduce this the least attractive portion of his work to within the smallest possible limits, and having, for example, by a boiling-point determination or a single analytical operation of the simplest kind, such as the examination of a platinum-salt, obtained a numerical result approximating to that which his theory demands, may hasten on to the further development of his airy structure, possibly not without risk to its stability. Unquestionably there are instances of frequent occurrence, in the pursuit of a particular line of organic research, in which more is not required than the identification of a particular product by some such simple means as above indicated. It is certain, moreover, that the labours of the organic investigator also not unfrequently afford bright examples of indomitable perseverance under formidable difficulties ; and this alone should constitute a strong bond of union between the worker in organic research and his brother-worker in analytical chemistry, if one did not already exist in the active interest which each, if a true lover of science, must take in the work of the other.

It has been remarked by one of the most distinguished investigators, and, at the same time, one of the most brilliant lecturers and successful teachers of our time, that the contrivance of a new and good lecture experiment may rank in importance with the preparation of a new organic compound ; and it may certainly be said with equal truth that the elaboration of a new and good method of analysis may rank in importance with a good research in organic chemistry, in reference both to the part it plays in the advancement of science and to its influence upon industrial progress.

Reverting to the industry of iron and steel, it is not difficult to demonstrate that the labours of the analytical chemist have exercised, and continue to exert, an important influence on the very considerable advance which has in recent years been made, and still proceeds, towards securing complete control over the quality and character of the products obtained. The epoch is well within the recollection of chemists of my generation when the British ironmaster first awoke to the benefits which might

accrue to him from an application of the labours of the analytical chemist in connection with iron-smelting. When the last great stride was made in the manufacture of cast-iron by the introduction of the hot blast, the iron-smelter was naturally led to seek profit, to the fullest extent, with respect both to the great increase in the rate of production of pig-iron attainable thereby, and to the economy achievable in regard to the proportions and characters of the materials employed in the production of pig-iron. But after a time, the great falling off in the quantity of a large proportion of the products of the blast-furnace, and the difficulties experienced in the production of malleable iron of even very moderate quality, directed the attention of enlightened iron-masters to the likelihood of deriving aid from chemical science, and especially from the investigations of the analytical chemist.

Professor Abel then recited the names of distinguished scientific men devoted to this branch of investigation, especially Mr. H. Blackwell, who presented to the Royal School of Mines his extensive and interesting series of British ores which he had collected with great labour and expense, and also placed in the hands of Dr. Percy the requisite funds for engaging the services of the competent analysts, Messrs. Spiller and Dick, who carried out a very careful and complete examination of the series under Government co-operation; and its results are of permanent interest to those actively engaged in iron industry. This had practical fruit in the connection of others with iron works, among whom he mentioned Messrs. Nicholson, Riley, and Dr. Price, that marked the commencement of systematic endeavours to apply the results of analytical research to the improvements and regulation of the quality of the products of our iron works.

It is, perhaps, but natural that the primary object sought by application of the knowledge of the analytical chemist should have been to eliminate or reduce the existing elements of uncertainty, in obtaining the most abundant yield of pig-iron capable of conversion into railway bar, sufficiently good to meet the minimum standard of quality, and to reduce still further the cost of production of such bar-iron by utilising materials concerning the composition of which (richness in iron, &c.) the iron-smelter was completely in the dark. The information accumulated by the analyist respecting the composition of the ores, fuel, and fluxes available at the works, and the composition of pig-iron and cinders produced under various conditions, in regard to materials employed, and to the production of ore, fuel, and flux, used in the blast-furnace, soon exerted a marked influence on the quality of the iron, and therefore, on the entire iron-industry. . . . . After further reference to Dr. Percy's literary labours as a metallurgist, and to Mr. Riley, whose labours continue to this day, Professor Abel adds: "It is needless to dwell upon the fact that the aid of the analyst has long become indispensable to the iron and steel manufacture;" and then describes Mr. Bell's investigations, and also those of Dr. C. W. Siemens, respecting the latter of whom we gave a few months ago an outline of his paper at some length, to which the reader is referred. Of Mr. Bell's work it is said, that in a paper before the Iron and Steel Institute, he brought together the results of an extensive series of practical experiments on the treatment of different kinds of pig-iron, of known composition in the finery, the puddling furnace, &c.—the Bessemer converter; and by comparing the results of analytical investigation of the products of those experimental operations with each other, and with those of the materials operated upon, he has obtained valuable confirmation already held by metallurgic chemists regarding the succession in which carbon, silica, sulphur, and phosphorus are attacked when pig-metal is submitted to the purifying process, and the extent to which those foreign associates of iron are abstracted, or resist removal, by the more or less thorough application of those several modes of treatment. He has also thrown new light on the reason why the most difficultly assailable impurity, phosphorus, obstinately resists all attempts to effect even a slight diminution in its amount by application of the Bessemer treatment. Indications have, however, not been wanting that the existence of phosphorus may ultimately become a benefit, and be turned to useful account, as in the alloys of copper and tin, and play a useful part in the production of special qualities of steel for special purposes. . . . .

The superiority of soft and very homogeneous steel over wrought iron of the best quality, in regard to lightness combined with strength and toughness, is leading to its very advantageous employment in the construction of a particular class of vessels for the navy; and the perfect confidence which can be placed in the uniformity, in structure and strength, of steel of such character as is produced by the Whitworth system of manufacture, has greatly facilitated the production of air-chambers of small weight, but capable of being quite safely charged with sufficient air, under a pressure of 1,000 lbs. on the square inch, to carry the Whitehead torpedo through water to the distance of 1000 yards in little more than a minute and a-half.

If it were necessary to add to the illustrations which Mr. Perkin gave in his address last year of the practical fruits of research in organic chemistry, I might be tempted to dilate upon the important results which have, especially during the last ten years, grown out of the discovery and study of the products of the action of nitric acid upon cellulose and glycerine. During the six years which have elapsed since I had the honour of bringing before the members of the British Association the chief points of scientific interest and practical importance presented by the history of those remarkable bodies, their application to technical and war purposes has been greatly developed. Nitro-glycerine and gun-cotton may now be justly classed among the most interesting examples of the practical importance frequently attained by the results of chemical research, while the history of the successive steps by which their safe manipulation and efficient application have been developed, affords more than one striking illustration of the achievements effected by combined physical and chemical research, in the solution of problems of high scientific interest and practical importance, and in the vanquishment of difficulties so formidable as, for a time, to appear fatal to the attainment of permanently practical success.

It is to a careful study of the influence which the physical characters of gunpowder (its density, hardness, &c.) and its mechanical condition (*i.e.*, form and size of the masses and condition of their surfaces) exert upon the rapidity of the explosion under confinement that we chiefly owe the very important advance which has been made of late years in controlling its explosive force, in its application as a propelling agent, and the consequent simple and effectual means whereby the violence of action of the enormous charges now used in siege and ship-guns is effectually reduced to within their limits of endurance, without diminution of the total explosive force developed. But, concurrently with these important practical results, the application of combined chemical and physical research to a very extended and comprehensive investigation of the action of fired gunpowder, has furnished results which possess considerable interest from a purely scientific point of view, as in many respects modifying, in others supplementing, the conclusions based upon earlier experiments and theoretical considerations with respect to the nature and proportions of the products formed, the heat developed by the explosion, the tension of the products of combustion, and the conditions which regulate it, both when the explosion is brought about in a close vessel and when it occurs in the bore of a gun. The results of these physico-chemical researches have, moreover, already acquired practical importance in regard to the light they have thrown upon the influence exerted by variable conditions of a mechanical nature upon the action of, and pressure developed by, fired gunpowder in the bore of a gun, and in demonstrating that modifications in the composition of gunpowder, not unimportant from an economical point of view in dealing with the very large charges now employed, may importantly contribute to render the storing of the maximum of work in the projectile, when propelled from a gun, compatible with a subjection of the gun to comparatively very moderate and uniform strains.

Other interesting illustrations of the intimate manner in which physical and chemical research are linked together, and of the important extent to which some of our most illustrious workers in chemistry have contributed to demolish the semblance of a barrier which existed in past times between the two branches of science, are furnished and suggested by the recently published list of grants of money which the Government has made to scientific men, on the recommendation of the Royal Society, from the fund which, for the first time last year, was added to the very modest sum previously accorded from national resources in support of research. The perusal of that list, representing as it does a most carefully considered selection by the highest representatives of science in the country, from a very large number of applications, affords important evidence, on the one hand, of the active pursuit of science in Great Britain, and, on the other hand, of the very wide range of subjects of interest and importance, the full investigation of which demands the provision of adequate resources. That the necessity for such resources needs but to be thoroughly made known to ensure their provision, even from other than national sources, has been demonstrated by the success which, in a comparatively brief space of time, has attended the efforts of the Chemical Society to establish, upon the foundation patriotically laid by one of its original members, Dr. Longstaff, a special fund, to be administered by the society, for the advancement of chemical science. An inspection of the list of contributors to this special fund in aid of chemical research, which, in about two years, has reached the sum of £4000, and from the proceeds of which the first applications for grants have recently been met, is suggestive of two observations: one is, that the proportion and amount of

contributions hitherto received are comparatively small from the source whence the greatest support of such a fund may naturally be looked for, namely, from those who most directly benefit by the results of chemical research. It is to be hoped that there are many prominent representatives of the chemical and metallurgic industries in this country who still intend to give practical effect to their natural desire to aid in the advancement of chemical science, and to the appreciation which they can hardly fail to entertain of the usefulness of this fund. On the other hand, it is a matter well meriting special notice that a very prominent section of the contributors to the fund is composed of some of the most ancient corporate bodies of the City of London. Most welcome evidence is thereby afforded of the readiness with which the City companies are prepared to respond to appeals for the substantial support of measures well calculated to promote progress in science. This evidence, and the combined action which they are even now contemplating for promoting the application of scientific research to the advancement of industry and commerce, by establishing an institution for technical education upon a scale worthy to serve as a monument of the true usefulness of wealthy confederations, must be cordially hailed as very substantial proofs that these representatives of our national wealth and commercial supremacy are entering upon a new sphere of activity which will more than restore their ancient *prestige*, by according them a new rank, more elevated than any which their importance could, in the past or future, confer upon them—a rank high among the chief promoters of our national enlightenment.

It is not to the credit of the hundreds who now obtain positions of affluence—that is from £1200 to £200 a year—solely by the teaching of abstract students whose labours could not by them be turned to practical account, by reason of the differential capacity of the mind and circumstance, but who have actually created occupation to practical chemists who would never have discovered anything. These should remember the benefits derived from others, and lay themselves under tribute to extend those blessings to succeeding generations.

SHIP-BUILDING.

THE Institution of Naval Architects bids fair to take equality of position with the elder scientific societies. There is no livelier combination of practical men in the country. The very names testify to the vitality and vigour of the association: Messrs. Scott Russell, John Penn, E. J. Reed, Barnaby, and others, under Lord Hampton as president, are men not likely to engage in an undertaking that is devoid of purpose, and which does not contain within itself the mightiest elements. The meeting at Glasgow appointed for August brings the subject before the public obversation, and as professional jealousy—a disease afflicting all special organisations of men—seems to be a little active, we will just see what has been done, and what is hoped for. The time is not so long as to have faded from memory, and the service not so raw as to be without result.

It is the habit of Englishmen to depreciate and conserve their institutions. Who that has lived forty years has not heard powerful denunciations pronounced concerning every existing form of combined men, who are united for a special purpose? But such conduct is both cowardly and, of course, despicable. Who that has lived forty years has not seen those attacked institutions arise by minding their own business, and being unregardful of what might be spoken? Good is always exposed to attack: by the malice of men it is made more pure, and its inherent spirit is seen to be unquenchable.

We will not scold or praise; but we will describe.

Eighteen years is more than a generation of active energy, and is always a period which, in societies or nations, is the seed time of what is almost certain to prove a good harvest, provided that the seed be good. And it need not surprise any one who has taken the trouble to observe the course and nature of events, if he should hear bewailings and fears and half despairing prognostications; these are the foreshadowing of a prosperous result, and instead of invoking a sympathetic melancholy, they should be regarded as the evidence of vitality, and the sure antidote to decay. The Institute of Naval Architects is more than doing what Lord Hampton hoped for in his inaugural address in 1860, when, after the ordinary compliments, he said, with the candour that has ever been manifest in all his public business, "I venture to intimate a doubt whether the skill of naval architects in England has kept pace with our superiority in other respects. Is it not a fact, that when the naval superiority of England was most triumphant . . . . we captured a French man-of-war, *Canopus*, which continued to be for a long period the model of English naval architecture." He then referred to the American schooner called *America*, and to the *Great Eastern* as the noble specimen of English naval architecture, and then said, "I think it is impossible to deny that much remains to be done. Steam has changed the principles which governed naval architecture. France, Russia, the United States, and England, are competitive. Our Institution is bound to take care that England wins, by the skill of her scientific men, and the proper construction of our vessels, so that heavy guns or heavy cargoes shall be under our national control."

Sir John Pakington (who is now Lord Hampton) spoke of the great acquisitions of knowledge in scientific matters connected with ship-building, and briefly referred to the services of the well-known and respected Watt, to Abethell, Laird, and Scott-Russell, the constructors of ships: to Peake and others in connection with Her Majesty's service, in association with Robert Napier, and Smith, in the mercantile marine; and Penn, and Maudsley, as shipbuilders and engineers.

"I hope," said he, "I shall say nothing to wound the feelings of any one connected with the beautiful science of ship construction, if I venture to doubt whether the skill of naval architects keeps pace with our general naval superiority. Is it not a fact that . . . . we captured a French man-of-war, *Canopus*, and made it a model and guide for English naval architecture? And did not our American brethren learn to skim the water under canvas with a velocity unattained in this country? And did not our Scotch neighbours make clipper-ships for Australia that rivalled the steamers? Ideas derived generally from America. Ideas which, when accomplished, England could appreciate and adopt. Brunel and Scott-Russel made the *Great Eastern*, and regained our national supremacy."

Lord Hampton then said, "much remains to be done." He was right. Steam had at last changed the whole face of ship-building, and all nations tried to win in the new market; but said his Lordship, "we are bound as Englishmen to take care that, beyond all question, England shall win that race, by our skill, our construction of vessels, and our power to carry engines, that have acquired a fame which has never been diminished, and from the beginning was excellent. But the transition was curious in its phases. They, the government, determined to make a vessel of 6000 or 7000 tonnage, iron cased, with one tier of guns, and to repeat the order. This was the *Warrior* and her sister, and we know what has grown out of that history, and how wonderfully the Institute of Naval Architects, on such a foundation, has acquired an everlasting fame, realising in fact the sentiment with which the president closed his address, "I wish the nation may have, as I am convinced they will have, reason to look back with satisfaction and pleasure at this day."

Admiral Lord Hardwicke followed in the bluff shrewdness of his nature. "We are met together to impart to each other our practical and local knowledge upon one of the most abstruse and delicate arts ever practised,—that of constructing floating bodies, possessing in combination the advantages of speed, power, weight-carrying, and safety; science lays the foundation that nothing but practice can elucidate."

The Institute issued a pape· by Dr. Fairbairn, afterwards Sir William, on the strength of iron ships; a question of supreme importance in those days. Laird and Fairbairn had been since 1830 constructing iron ships for sea-going on more secure probabilities than could be attached to the wooden ones. Fairbairn built Scott-Russell's works at Milwall; and while he held them more than a hundred vessels were built. What Scott-Russell has become upon the foundation laid by Fairbairn we all know; but we also know that Fairbairn's idea of building ships that are to go upon rocks in heavy seas without going to pieces has not been realised, but building in compartments, then established, has effected, more than any other idea, a protection to life and the salvation of property.

Sir George Airey, whose useful career we referred to three months ago in a very fragmentary way, gave a paper on a most difficult subject, the correction of the compasses in iron ships. The magnet dislikes the presence of iron—so to speak—and the Institute performed a great service in obtaining the opinion of the Astronomer-royal on those disturbing influences.

We find that in its first year most important documents issued from the Institute. Barneby's paper on mechanical invention in its relation to the improvements of naval architecture; the paper of Lennox on chain cables; Murray on economising fuel, and Scott-Russell on ship construction, are contributions to general knowledge, that it is impossible to over-estimate.

At the second annual meeting General Douglas forwarded a concise, although rather controversial paper on iron ships, and iron-cased ships, in which (1861) he warmly contended for the

mixed description, as described in his *Naval Gunnery*, in opposition to Mr. Scott-Russell, who advocated iron, giving his practical experience about ships rolling, as tenfold more disastrous in vessels made of thin armour plate than those iron-clad wooden vessels. This was followed by J. Daginlar Samuda and Mr. Scott-Russell, on the same subject, and by Mr. Longden, shipbuilder,—on a new mode of constructing shot-proof war-ships. These were followed by an evening discussion of the several ideas and opinions. Had the Institute done nothing more it deserves the public gratitude for this free ventilation of a subject, and a time of great anxiety and speculation.

We notice in these institutions how easily the subjects are selected, and their entire appropriateness; the second year branches out of the first by taking relative subjects to those already discussed—the like remark applies to the Engineers' and other scientific bodies. Elaboration, detail, and tabular matter, are thereby published in a permanent form, such as could not be obtained from controversy, or lecture, or pamphlet.

The third year was occupied with papers on the rolling of ships, mathematically treated, Professor Airey on deviations, &c., the construction of marine boilers, the manufacture of armour plates on fixed floating vessels; and on the best ships for telegraphic cable-laying; out of which discussion arose a greatly extended interest in having telegraphic communication with America—a benefit not then enjoyed, but which is growing in public service every day.

In the fourth year, 1864, the subject of naval education engaged the notice of the members, and again the combination of opinions which differed illustrated the advantage of such an institution. Several members spoke against making separate schools, with the three-year system of teaching in classes, as being unsuited to the undeveloped mind, and not likely to produce lasting excellence. Practical papers on steering of ships, constructing iron-plated ones, the protection of them from oxidation and fouling, ship rolling, and the like—every volume being accompanied with first-class plates and elaborate tables.

Year by year some twenty or thirty papers are read, and half-a-hundred gentlemen take part in the subsequent discussions. The subjects are practical and demonstrative, and, therefore, as all is brought to the test of experience and reason, there is little scope for vain words or useless occupation of time. The objects of the Institution which have been kept well in sight, are, first, The bringing together of those results of experience which so many ship-builders, marine engineers, naval officers, and yachtsmen, acquire independently of each other in various parts of the country, which, although valueless when unconnected, tend much to improve our navies when brought together in printed transactions. Second, To carry out inquiries essential to the promotion of the science and art of ship-building, which are too great for private enterprise. Third, To examine new inventions and investigate professional questions left open, because these have no public body to which appeal could be made. In furtherence of the latter, a permanent Committee exists. In the second item we remember the distinguished men who met fourteen times to investigate the scientific facts concerning that terrible catastrophe—the loss of the *London*—and a spirited appeal was made to the government of the day (1867) for some rigid directions, which they prescribed in the interests of the passengers on sea, to protect them from dangers arising from overburden or otherwise.

The Institute set up a school for naval architecture, after due deliberation, notwithstanding the objections originally made; and it has been a most successful auxiliary to naval education.

Again, when the subject of turret-ships was at last settled by Government giving Captain Coles *carte blanche* in the construction of the ill-fated *Captain*, we find the Institute remonstrating about the perils of surrounding vessels of that construction, which remonstrances, though overruled, were more likely to be justified by events than the casual objections of individuals upon another occasion, when (1868) Lord Hardwicke presided, and in his speech said—"No doubt, gentlemen, this Institution flourishes, and I hope it may continue to do, for undoubtedly it lives in times when it is very much needed, to direct or to weigh upon the councils of the naval portion of national powers. We want advice, for I may venture to say in broad language—I do not know whether it will receive an echo or not—that you have got a Royal Navy which I very much doubt being worth one twentieth part of what it has cost. *I believe that it will not float.* Now that is a very strong proposition; if true, a damnable proposition. I believe that such is the form of the floating body of a man-of-war, such is the manner of construction, loaded as it is inside and out, that if one should be in service obliged to throw her guns overboard, the ships will go overboard to that respectable situation, vulgarly known as 'Davy Jones' Locker.' Not one of them could throw her guns overboard. It ought not to be." &c.

In the following year, Sir John Pakington had the sympathy of the audience when, in a delicate way, he deprecated the resolution of the naval controller to build ships without masts, and carrying for dead weight near 2000 tons of coal, as most dangerous. He wished any good idea success, and would rejoice if his fears were proved to have been groundless. This was national service on the part of the Institute, and entitled it to Government recognition, which recognition took the form of a small grant of £250 a-year.

In 1870, the subject of the rule of the road at sea came on, consequent upon the frequent collisions which occurred in the previous year, and the management of ships when dense fogs obscure all objects from vision, with a view of compelling more caution and diminishing the speed; the construction of a steam-ferry across the Channel; and what was the best form for passenger vessels intended for the Suez Canal route, that is, shallow water; and, lastly, the overloading of merchant ships—what are the stipulations the public should require?

The following years witnessed the same excellent service; the financial position became sound; the School has been removed and taken to Greenwich, to everybody's satisfaction.

But the great services rendered to our nation in the invaluable treasury of papers the Institute of Naval Architects has produced, is its distinguished claim to general esteem. But for that those papers would never have been written; its leading minds would never have shown anything like the energy, or have sent abroad the flood of light they have, to the honour of their profession, the edification of their society, and the instruction of their youthful members, to say nothing on the information imparted to them, to our public men, had not this Institute existed. Its management has been unimpeachable, and many a time its great majority have shown a determination to continue doing the good work it was created to perform, from which it will not be diverted by the captiousness of critics, or the envy of detractors.

FLOATING DOCK AT NICOLAIEFF.

NICOLAIEFF ARSENAL is the southern dockyard of the Russian Government; is impregnable to attack, and very much less ice-blocked than any northern ports. In the river is ample depth of water, well surrounded for the accommodation of a large navy, and with abundant workshops and machinery. Popoff's circular ironclads and other iron vessels, were made and fitted there, and from thence came the torpedo boats we have heard of, and torpedoes surround the place more plentifully than in any other port. The want which pressed upon the Government bitterly was the construction of a graving dock, for if those ironclads of Popoff's were to be continued, there was no room. The amount of pumping was becoming prodigious, and gates or caissions of 120 feet diameter ridiculously impossible, when Admiral Popoff determined to avail himself of the most recent resources of science, and has accepted a form of dock of English invention, which is capable of accommodating vessels of any size or shape, and which, although only a single dock, practically takes the place of 20 or 30 ordinary graving-docks by its capability of lifting the vessels on and off a range of building and repairing stages fixed along the shore. This dock has been in course of erection nearly a year in the Admiralty Dockyard at Nicolaieff, and the first portion was completed, and officially tested a fortnight ago. The whole will be completed by October. This dock, which is the first of the kind, instead of entirely enclosing the vessel as in ordinary docks, passes a number of parallel fingers, so to speak, sideways under the vessel, and lifts it entirely out of the water, and then deposits it on a corresponding set of fingers constructed of piles driven into the shore, as the fingers of the right hand might support an object, and by passing between the fingers of the left hand deposit it upon them. The vessel is thus transferred in the readiest and simplest manner from the water to the staging, or from the staging to the water, as required. The section of an ordinary floating dock resembles the letter **U**, with the vessel lying within, but the section of this dock resembles the letter **L**, with the vessel resting upon the lower limb. This consists of a number of parallel pontoons or fingers, which are floated under the vessel so as to raise it out of the water. These fingers are attached to the side of the dock at uniform distances, and stand out from it like the teeth of a comb. When the dock is at its lowest level in the water the pontoons and about three-fourths of the upright side are submerged, but as the pumping proceeds the dock gradually rises

until the pontoons come above the water, carrying the vessel on them, while the side stands up high out of the water, its deck being higher than the deck of the vessel. This side portion is 280 ft. long, 12 ft. broad, and 44 ft. high, and the pontoons which project from it at right angles are 72 ft. long, 15 ft. broad, and 18 ft. deep, with a clear space of 5 ft. between every two, to allow of their passing between the rows of the fixed staging. The floating power of the pontoons or fingers is sufficient to carry the whole weight of the vessel, the office of the side of the dock being only to keep the pontoons in position, and to enable them to be submerged and guided beneath the vessel; the side also contains the pumps and machinery. At the back of the dock is a large floating pontoon or outrigger stage, which guides the dock in its ascent and descent, and keeps it at all times perfectly upright. This outrigger stage, which is the same length as the dock, gives it unusual stability. The dock is constructed in three similar lengths, each complete in itself, and capable of use as a smaller dock; any two of these being united face to face are suited for raising circular vessels, but when three portions are united end to end they are suited for raising long vessels of the ordinary form.

The first portion of the Dock has just been launched and officially tested: a vessel was docked and undocked in a gale of wind of great violence with ease and safety. The best men in the fleet attended Mr. Stansfield, and at the end expressed their pleasure at the celebration by which the future width of vessels could be manifestly increased indefinitely. The dock proved to be thoroughly efficient, and the English contractors received high praise from all present. It had been constructed in the Thames, and then taken to pieces and transported to Nicolaieff. This service in the way of docking accommodation equal to any graving-docks did not cost more under Messrs Clark Stansfield's contract than £100,000, and is regarded as one of the finest specimens of naval construction.

A general view is given on page 205, but a technical description may further illustrate this efficient and comparatively inexpensive plan.

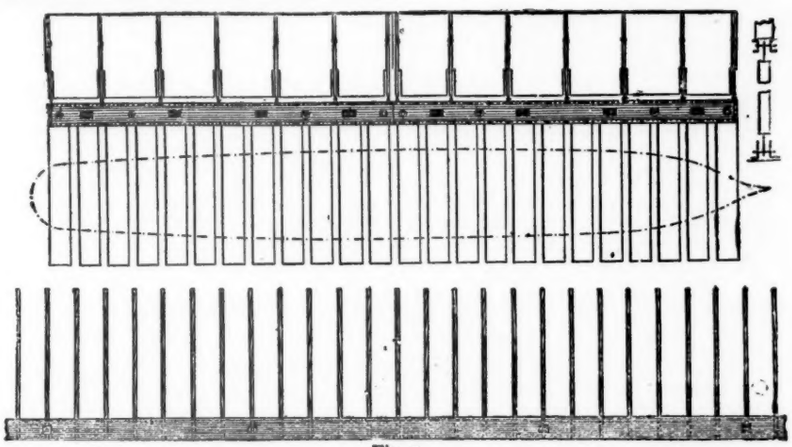


Fig. 1.

The upper portion of Fig. 1 represents the upper surface of several rows of piles, driven parallel into the shore, and having between them a clear space of water; there is a side view of one of these rows of piles in Fig. 4. These piles form the grid-iron staging from which the Dock is named. The operation of docking is effected thus:—The dock is lowered by means of letting water into its pontoons, or fingers, as shown in Fig. 1, and in side elevation in Figs. 2 and 3, to a sufficient depth to

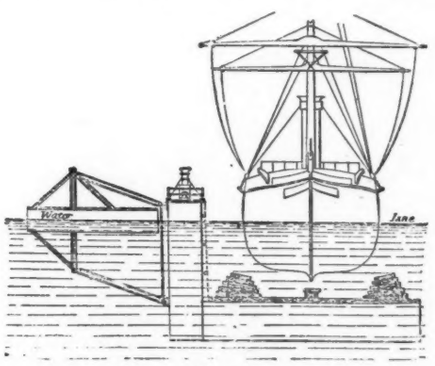


Fig. 2.

allow the vessel to be brought over it, as shown in Fig. 2 in this position. The side of the dock has a free-board of several feet, the water is then pumped out of the pontoons by means of powerful centrifugal pumps carried in the upright side; this causes the dock to rise gradually and steadily with the ship on it as shown in Fig. 3; the dock with the vessel is then hauled into position opposite the staging, its pontoons passing between the parallel rows of piles, and the vessel being clear above them. A little water is then admitted to the pontoons, causing the dock to be lowered, and shifting the bearings of the vessel from the pontoons of the staging without any rolling, sliding, or any such

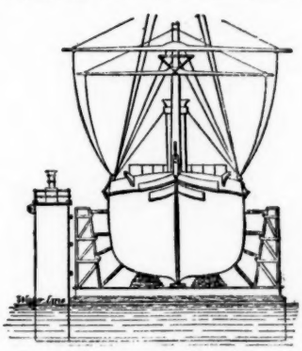


Fig. 3.

movement. This brings the vessel to another set of blocks as shown in Fig. 4. The dock being clear of the vessel is withdrawn, and is at liberty to lower a vessel into the water, or to deposit another on some other part of the staging, which staging may be of any length desired. The outrigger balance shown in Figs. 1, 2, and 3, is attached to the side of the dock by a parallel motion, which insures stability when raising or lowering a vessel. The form of joint is shown in Fig. 1. When the vessel has been raised, as in Fig. 3, the outrigger may be disconnected if it is desirable, as for instance, when taking the dock through a narrow channel or entrance. The outrigger always floats, and therefore its movements are the same as those of the dock, any movement of which causes the lifting out of the water of one side of the outrigger, and a corresponding submergence of the other. The force requisite to cause such a movement, even through a small angle, amounts to several hundred tons; but with ordinary management not more than two tons of this righting power is called into exercise, because the valve

engineer immediately rectifies any tendency to movement. Owing to the neat width of the dock, the whole structure is eight or ten times more stable when afloat than the vessel herself.

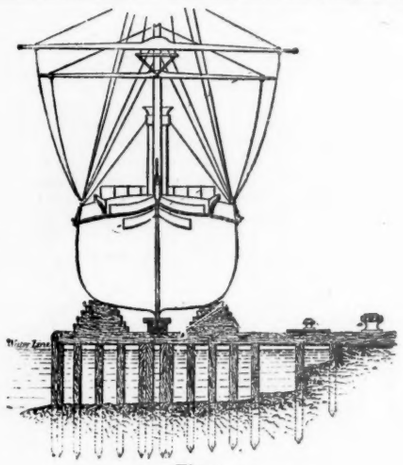


Fig. 4.

Figs. 1, 2, and 3, also show that the pontoons of the dock are fixed to the vertical side at one end, but are left quite free at the other. These pontoons are divided into several watertight compartments, each communicating by a separate pipe with the valve-house. The pipes are in four groups corresponding to

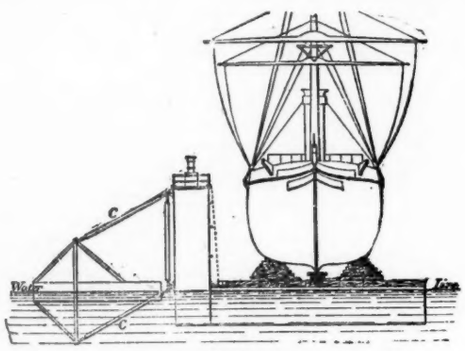


Fig. 5.

the four corners of the dock, and are each governed by a principal valve. The engineer in charge of the valves can see at a glance, by the spirit-level in the valve-house, what tendency to movement may be in operation; and by adjustment accordingly keep the dock level. The buoyancy of the pontoons alone constitutes the lifting powers of the dock; the side is not used for that purpose.

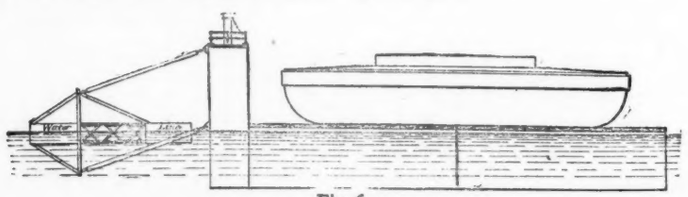


Fig. 6.

Perhaps in some cases a cradle might be employed to carry the bilge blocks, &c., whereby a transfer could be made bodily with the ship from the dock to the staging, and *vice versa*. A special cradle with side shoring-frames for heavy vessels is shown in Fig. 5; but an ordinary cradle is formed simply by a series of light cross iron girders.

The dock now constructed for the Russian Government has distinctive features. As stated, the length of 280 feet is divided into three portions, the outer ones are 100 feet in length and the middle one 80 feet. Usually the dock would be made in halves, both equal of course; each complete in itself as a small dock with proper machinery for docking itself, or for cleaning and repairs.

Admiral Popoff of the Russian Imperial Navy offered suggestions that have been engrafted on Messrs. Clark, Stansfield's Scheme. The pontoons of the Nicolaieff Dock, 72 feet in length, are not permanently attached to the side: they can be placed end to end and thereby double the width of the dock, as in Fig. 6.

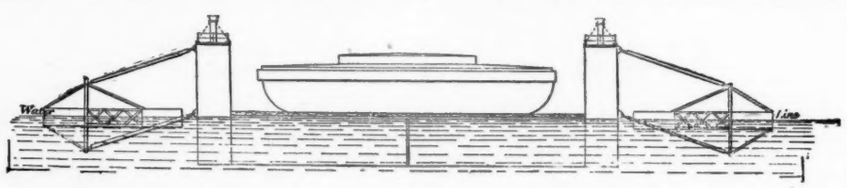


Fig. 7.

It will be observed from Figs. 6, 7, and 8 that the outrigger is like two parallel pontoons well fixed: it has a width of 45 feet for each pontoon, and a width of 15 feet distributed in proportion as regards dock and outriggers.

The docker is, from the connection of its portions in a straight line, always ready for ordinary vessels, but when arranged as in Figs. 7 and 8 any vessels, circular or singular in shape, are equally manageable, and that is the distinctive property of Admiral Popoff's suggestion as applied to what Messrs. Latimer Clark, Stansfield & Co. have already accomplished. There is the arrangement in Fig. 6 removing the outrigger previous to the docking of, and thereby it is evident that docks can be constructed for any width or diameter without any reference to dock gates and other difficulties. This dock can take much and raise anything.

The many ways by which this dock may be utilized need not be described. It may be short or long; for deep or for shallow water; for floating over bars or through channels, and for ferrying. Mr. Latimer Clark (Clark, Stansfield, & Co., London), the inventor, claims the following characteristics in his paper read at the Institute of Naval Architects:—

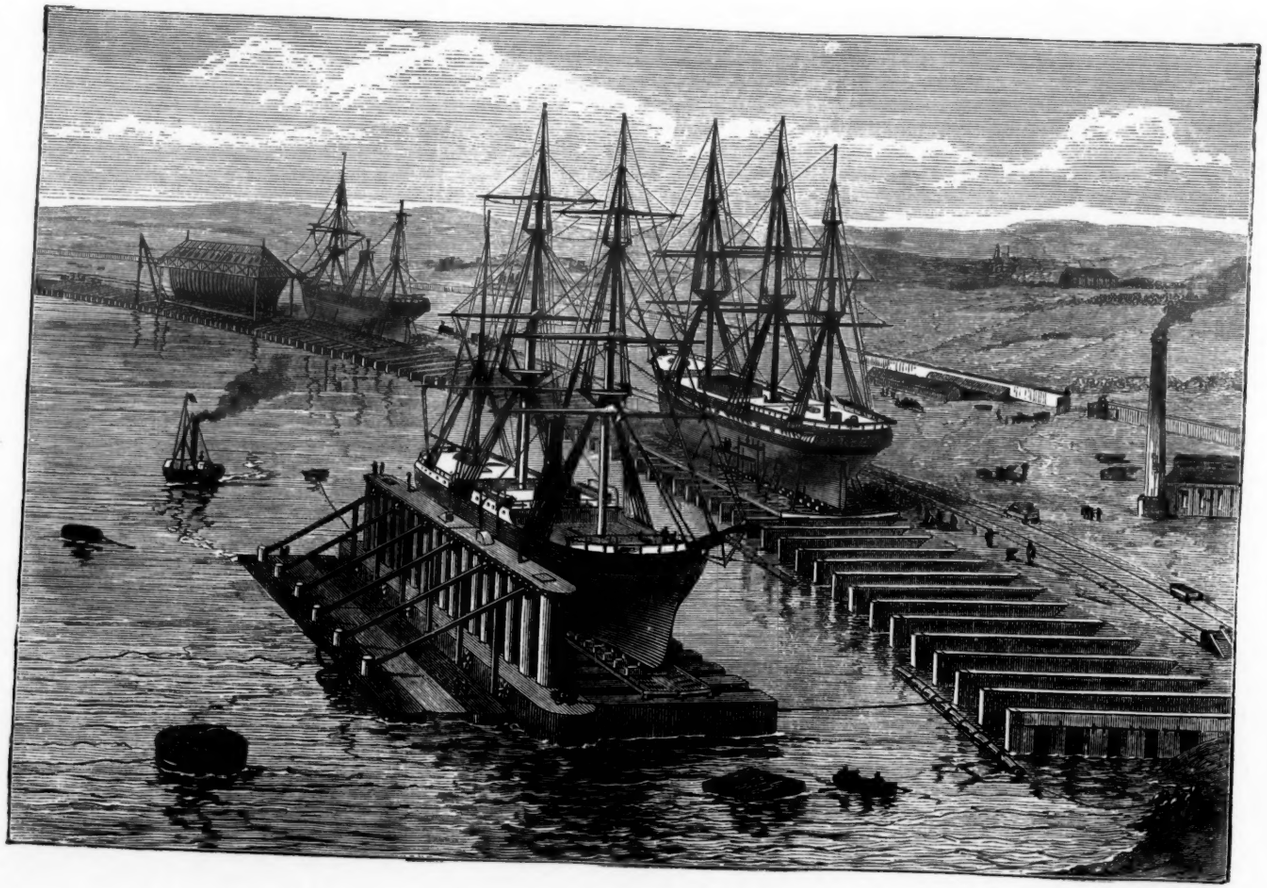
1. With one dock any number of vessels can be docked and deposited high and dry out of water on wooden platforms, in a convenient position for cleaning and repairs, along the waste sloping shores of a river or dock.

2. The provision of an additional length of staging, at a comparatively nominal cost, is equivalent to the building of an additional dock.

3. As the dock is used ordinarily for lifting vessels on to the stage, it can be kept at all times ready to receive disabled or other vessels, which can be at once deposited on a stage and the dock left free for further use, and in this respect has a great advantage over all other descriptions of graving docks.

4. A vessel can be placed upon the staging, cut in two, and readily lengthened by lifting one half further along the staging by means of the dock.

5. Vessels can be conveniently built on these stages on an even keel and launched without the slightest strain, and without



the risk and cost of launching, and without occupying the space required for the formation of ordinary ship ways.

6. Vessels, when on the dock or stages, are thoroughly exposed to the action of sun and wind, allowing paint to dry and harden rapidly, and affording great facility for examination and repairs.

7. The dock, with or without a vessel, may be readily transported from place to place, for the purpose of raising or depositing vessels at different points.

8. The dock will not, under any circumstances, sink, even if all its valves be intentionally left open.

9. One half of the dock can be readily raised level upon the other half, for the purpose of cleaning or repairs.

10. By the use of air, which may be stored in some of the cylinders under compression, a vessel may be raised, sighted, and lowered again in less than an hour.

11. These docks, if constructed in the first instance too small for the requirements of trade, can be at any time enlarged to any extent at the same rate per ton as the original cost.

12. The docks are capable of receiving vessels of any size or length, or of a width too great to pass through ordinary dock gates; such, for example, as circular ironclads of 100 feet or 150 feet in diameter.

This practical work of Messrs Clark, Stansfield, & Co. has necessarily a political bearing. We continually find our

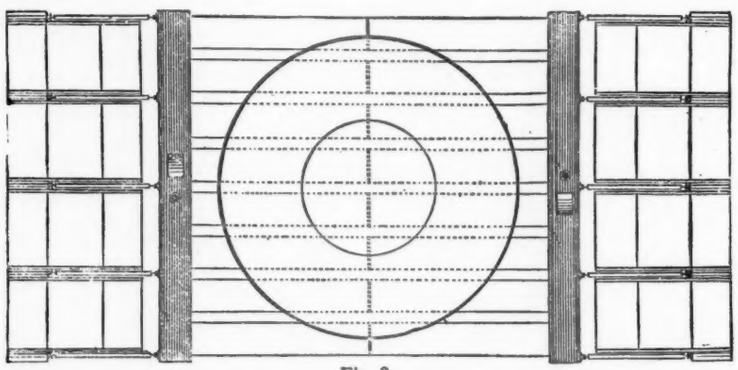


Fig. 8.

engineers engaged in the construction of works, permanent and floating, that evidently show to us the necessity of employing similar efforts for the purpose of defence or for protecting existing interests and our traditional position. This Nicolaieff dock shows the necessity for the like structures at various points which would become jeopardised in the event of war being declared. As far back as 1873 Captain Columb pointed out that the defence of the Empire must necessarily be based on the protection of certain great lines of communication with our Colonies. These are :—1. Across the Atlantic to British North America ; 2. To the West Indies ; 3. To India, China, and Australia, round the Cape ; 4. Australasia, and the Pacific, round Cape Horn ; 5. To India and Australasia, *via* the Suez Canal.

The bases of defending these important lines would be generally the points which are used as commercial centres in times of peace, and these can be classed into two groups, viz :— 1. Fleet centres, provided with permanent defences, coaling stations, and docks, capable of repairing the largest class of war vessels. These centres include England, Halifax, Bermuda, Simon's Bay, Bombay, Sydney, Hong Kong, Vancouver's Island. These have docks well enough for commercial exigencies, but not likely to be efficient in time of war. 2. Squadron centres, provided with fortified coaling stations, and small docks that are moveable, such as at Jamaica, St. Helena, Mauritius, Singapore, King George's Sound, and the Falkland Islands. These are nearly all without docks.

In a naval war it would be essential that our main lines of communication should be protected and provided with fortified coaling stations and means of repair. If through false economy there should be neglect of these precautions, the loss to the country would during each week of interruption far exceed the whole cost of the necessary establishments.

If these coaling and repairing stations be not provided, it is obvious that our costly ironclads would be powerless for continued action at these vast distances from England. A comparatively slight accident which might with proper appliances be readily repaired on the spot, would for the time being practically extinguish her from the Navy-List, and compel her to leave her station unprotected while she would have to perform a tedious voyage home in a disabled state, and at the risk of capture from much inferior craft.

It may be objected that the country and the colonies would not readily sanction the expenditure of a large sum for the provision of naval stations, which may possibly never be required for Imperial purposes, and there are unhappily to be found many who have lived in security all their lives, and having never considered to what that security has been due, would gladly continue to trust to the chapter of accidents and the forbearance of other nations ; but it must be obvious even to these that the proper view to take of such expenditure, is to consider it as an *insurance of the commerce* protected by it, in which light even the most inveterate peace lovers will not object to its principle.

The whole exports and imports of Great Britain have been estimated at about £655,000,000 per annum, and if we add to this the value of the intercolonial commerce, it is probable that the total might approach one thousand millions sterling per annum, irrespective of the value of the ships by which it is carried. By far the greater part of this would be dependent on the Navy for protection during war.

In a paper read by Mr. Latimer Clarke on the 11th of June, he drew attention to another subject of increasing interest,—the raising of sunken ships, in which he stated that in our old naval engagements we know it was a very usual thing for a great many vessels to go to the bottom, and I do not know that the modern system of torpedo warfare is at all calculated to diminish the number ; therefore it has been thought that it would be very desirable, if it could be managed, to regain those vessels, and for that purpose Mr Stansfield and myself have designed a form of dock suitable for lifting them. It is quite evident that if these vessels were simply ordinary boats there would be no hesitation about making a machine which would go down and pick them up with the greatest ease ; for if we imagine a human being of sufficient size to reach them with his arms, and to put his fingers underneath, he could lift up vessels of that size. We have endeavoured to deal with the sunken vessels in a similar manner, and for that purpose we have designed a dock, the construction of which you will understand on reference to the diagrams. It has within it, along each side, a number of hollow grapnels or clips, constructed of boiler plate, which come out beneath the bilges of the ship, and lay hold of it. These grapnels or hooks are thrust forward by the inflation of large air-bags behind them. In using the dock, it would be floated over the vessel, and if the masts were above water they would be cut off a little below, so that the dock might pass over them. It would then be gradually lowered over the vessel, and if the masts and funnel are still standing they would pass through the openings of the dock. Then if there is any sand accumulated, or the vessel is to some extent embedded, the sand would be thrown out by violently ejecting streams of water from a large number of holes ; by turning on a large reservoir of compressed air a tremendous swirl of water and sand would be made, and a clear space would be obtained, and a single pair of nippers would then be forced forward. Then the sand in another space would be driven out, and another pair of clips made to grip the vessel, and so on, till perhaps thirty or forty pairs have been adjusted, and the vessel is entirely gripped in this manner. Last of all, air is ejected from the dock itself and the buoyancy will then be sufficient to raise the vessel to the surface, and in that state the dock and vessel would be towed away and deposited in shallow water. After an action I think it is extremely possible a very large number of vessels, both of the enemy's and our own, might be quickly repaired and again brought into use.

It may not be a very long distant future when it will be worth

considering whether some machine of this kind might not be a profitable investment, for if only two vessels were recovered it would be a good speculation, and if half-a-dozen were recovered it would be a large saving.

THE MANUFACTURES AND RESOURCES OF ITALY.

ITALY asserts her position as a nation among the nations in a manner that has never had a parallel. Her rise is one of the most wonderful political creations the world ever saw, and her development a phenomenon as astonishing to her children as it is gratifying to all mankind. Great in the history of the world as the nursery of art and the mother of poets and patriots, she is now assuming a distinct political and social conspicuousness as great and honourable as until lately it had been insignificant. The genius of the age finds there a home. Not less great in art and patriotism, she is beginning to rival her neighbours in industry and practical science.

There has just appeared a report from Mr. Colnaghi on the resources and industries as they exist, accompanied with remarks showing by contrast the immense progress that has been made and the probabilities concerning the future. In speaking in this hopeful way it is of course understood that Italy has no present claim to any actual rivalry of the enormous manufactories in the European kingdoms of France, Great Britain, and Germany, but we shall see, and see too with pleasure, that a future is in her grasp that will place her as high among the industries of Europe as she is politically so from her self-acquired freedom.

Leather is one of the best of the industries in North Italy, and is likely to be speedily conducted on an extensive scale. The processes adopted are undergoing rapid changes which, without deteriorating the quality, will improve the finish of the leather, in which hitherto there has been a marked deficiency, and of course produced lower prices in the market. The processes have always been good, but the goods turned out were rough. An export trade has sprung up: small quantities are being regularly sent to France and Germany, and that makes the improvement in manufacture obvious: for those nations have no market for the inferior goods of their neighbours. The kinds in demand are chiefly. shoemaking leather, both soles and uppers; leather for saddlery; belts for machinery; and leather prepared from lamb, and kid skins for gloves. One-third of the hides and skins are supplied by Italy, and the other two-thirds are imported in either a dried or salted state to the markets of Turin, Genoa, Aosta, Ancona, and Leghorn, from Trieste, Calcutta, and London. The Suez Canal has conferred great advantages on Italian trade, by placing it in the most direct communication with our Indian possessions, and a rapidly increasing trade has been created since the completion of that great work. Cow-hides are shipped at Calcutta and imported direct, instead of as formerly being sent through the London market: the extra cost of transit is covered by the rapidity of transactions, and by-and-bye, as the trade augments, the qualities will be selected for the Italian market alone, to the extinction of British export trade except so far as cross freights and exchanged commerce will require. The bark used in Italy is chiefly the oak-bark, and is procured from the States of Piedmont, Lombardy, Tuscany, and Romagna.

The glove factory of Messrs Fiorio in Turin employs sixty men and twenty-five women on the premises, and almost three hundred others who work at home and do the stitching. These make about ten thousand dozen pairs of gloves every year, and export in equal proportions to France and England. Another branch of export is in kid and lamb skins, the country yielding more of those materials than it requires for its own use or manufactures, and hence they are sent to France and Germany.

Metal-working in every department is assuming an increasing importance throughout Italy, notwithstanding that the present proportions of raw material in the country is small. The land contains abundance of ore, but as yet there has not been sufficient time to set up the necessary machinery for turning it to account. England and France have hitherto supplied most of the iron, but we shall lose that market when Italian capitalists or foreign enterprise explores the soil and collects the metallic products buried there. There is already a considerable supply sent in Lombardy and Aosta; and the factories have acquired much skill in converting old iron of all sorts in great quantities. Steel is imported from England and Germany; copper from South America, with which Italy has always had an advantageous commercial connection; but there are copper mines in Italy, and these will soon be extended; zinc is brought from Silesia; and brass, chiefly in sheets, is obtained from France.

The hill districts of North Italy have a flourishing industry in the manufacture of cheap furniture, particularly chairs, and have an extensive commerce in exporting them to Egypt and South America. In Turin, furniture of a superior description is largely manufactured, and the cabinetmakers and upholsterers of that district are famous for their skill. The taste may not accord with our ideas of excellence, but the workmen are distinguished for intelligence, good conduct, and industry. Musical instruments is a staple industry among them, although not very extensive. Somewhere about 800 pianofortes, barrel-organs, and harmoniums, at prices varying from 500 to 1200 lire, are made annually, and one maker, M. Marchisio, obtains as much as 2000 lire for his class of pianos. No one would expect that Italy can turn out the magnificent instruments that have made the fame of Erard, Collard, Brinsmead, and Broadwood, but the work of her manufacturers effectually shuts out of their market the second-class goods formerly imported; but this has a taint of commercial immorality, inasmuch as it is a not unfrequent habit of the Turin maker to affix a well-known foreign trade mark on his instruments, thereby passing them off as imported goods, whereas they are home-made.

Italy abounds in fine woods, suitable for this class of manufacture, but the cords, pegs, ivory, and hammer cloth are imported. The largest maker in Turin is M. Argmonino, and he turns out 300 pianofortes and harmoniums every year, exporting some to Turkey, South America, and Austria.

The employment of women in industrial occupation prevails throughout the country, notably in such labour as silk-spinning and throwing. In the commune of Turin, there are only two spinning mills, one a throwing mill belonging to Messrs Dupré, near the Mosca Gate, and employing 200 hands, and the other near the Ceronda Canal is almost of the same extent. Another branch of silk working, that of ribbon-making, flourishes there. One factory —M. Tasca's—contains 190 of those wonderful looms for which Lyons is famous, and which were displayed at the recent exhibition of scientific machinery at South Kensington. Half of these automatic looms are engaged in plain ribbon-making, and the other half in figured. There have been added since 1870, 180 machines for making silk and woollen braid. Besides, M. Tosca's factory for the employment chiefly of women, M. Soleis for the production of brocades and damasks, for furniture, &c., must not be omitted, for it contains 100 looms, and the business is increasing by the establishment of branches in the chief cities of the kingdom, not only for manufacture, but for mercantile purposes, and these are conducted with exemplary energy and integrity.

In textile fabrics and their correlatives, a good beginning has been made: at least, although not entirely successful in the start, there is no doubt a sure foundation is laid. The cotton mill of MM. Mazzoni contains 11,494 spindles for singles, and 2,188 for twists, employing 200 persons. Woollen manufacture in Novara is in a flourishing condition, but the experiments of introducing it elsewhere assumed a too ambitious character, and a partial failure ensued. Manufactories depend more than could at first view be expected on the skill of the workers. Although machines can do almost everything but talk, they are absolutely dependent on human intelligence for their application, and if a capitalist imagines that by erecting his works he can create the hands to guide them, he will have to rue the consequences. Italy has not yet grown a race of factory operatives, and they cannot be imported at a profit. Therefore the lapse of time alone can bring a remedy by applying the cheap labour of the native population to manufacturing uses, and while elevating the worker by an augmented revenue, will enable the capitalist and manufacturer to secure a good return to all connected with his enterprise.

Hat-making is another successful branch of Italian manufacture, particularly in those made of felt, of which a fair export is made to South America, and an almost universal trade at home. Italians wear them in town and country, insomuch that we might almost look on the felt hat as characteristic of the Italian.

But we must not lose sight of those industries engaged in the supply of the physical wants of the native population, and the residents in other lands. These works are great. Rochert, Gay, and Co. produce, it is said, more than a thousand kilos of chocolate every day, and their rivals, Moriondo and Gariglid, and the house of Bass—all in Turin—are almost co-extensive. These are essentially home manufactures, for the material is not Italian; it is imported from the ports of Bordeaux, Lisbon, Hamburgh, and London.

Italy is prospering most remarkably in the trade by export of vegetables, fruit, poultry, eggs, and several other articles of food. It was a trade inaugurated and carried on under very trying and difficult circumstances by the well-known provision dealer, M. Cario of Turin, whose energy and fertility of resource have made him not only a successful merchant, but a national benefactor. When he commenced in 1869 by sending a few waggon loads he

struck a vein that has enriched many besides himself. In the following year he sent out two a-week; in 1871, four a-week; and now his trade fills ten to twelve waggons a-*day*. The principal articles are vegetables from the Neapolitan provinces, and fruit from Piedmont; and the trade in fruit, poultry, eggs, and preserves, in soups, meats, and vegetables, is confessedly in its infancy, great as it is destined to be and of the very highest benefit to the country, because it sends out the surplus riches and brings back money to the native community.

In England we count rabbits as vermin, much to our scandal. In our last volume reference was made to the enormous supply of food obtained from this source, and the number of thousands who actually derive their means of existence from the treatment of the skins, and working them up. The enlightened furriers, Costamagna & Son, imagining that rabbit skins could be utilised in Italy, and perhaps afford a ready and abundant supply of food for the poorer population, made arrangements to import the breed, and the race is there, as here, prolific, providing both food and employment for an increasing number of the labouring classes.

These facts chiefly affect the district of Turin, but throughout Italy the like growth is manifest. The royal city that despaired when political exigency compelled the Court to move to Florence, and thence to Rome, has risen like the kingdom from its melancholy; and, by becoming a trading and manufacturing centre, has shown again the importance of a people being self-dependent; and illustrates again that the sources of wealth and honour are in the industry and commerce of a free people.

WATER SUPPLY FOR DRINKING AND FIRE EXTINGUISHMENT.

NOT only is London anxious on this question, but all the great towns throughout the country. Many fine examples have been set the Metropolis by the large municipal boroughs, and their experience has done more than anything to relieve the pressure of fear and despair that surrounded the subject as it affected London. It must be of abiding interest to record the substance of an important paper read at the British Association Congress at Plymouth, which emanated from Messrs. Bramwell and Easton, gentlemen who had been requested by the Board of Works to report. The data supplied must be of great service to all large proprietors whose property is in towns, and whose desire is to do all that can be done to provide protection and supply in all matters dependent on the abundance of good water. They therefore reported upon the water supply to London, especially in relation to the quality of the potable water and to the provisions of water at an adequate pressure for the extinction of fires. We make no apology for bringing the subject of the London water supply before this section, because that subject is an extremely large one, and the questions involved in its economic considerations are, therefore, of very considerable importance. In 1874, the population supplied was 3,655,000, dwelling in 511,000 houses. The daily average quantity throughout the year was 116,250,000 gallons. The quantity per head, therefore, for all purposes, was a little under 32 gallons. As is well known, this water supply is in the hands of eight companies. The aggregate capital employed in 1874, including share and loan capital, was £11,196,000. The gross income from water was £1,137,000; in addition to this there was £16,000 from land rents—making a total of £1,153,000. The expenses were £447,500. The net income was £705,700, giving a rate of interest upon all the capital employed, share and loan together, of proximately 6.3 per cent. In Colonel Bolton's last report, June 1877, it is stated that the population supplied was 3,796,000, dwelling in 533,000 houses, and that the average daily quantity was 132,500,000 gallons, equal to a little less than 35 gallons per head during this summer month, and representing a probable average daily delivery throughout the year of from 120,000,000 to 125,000,000 gallons. London, in common with other towns, requires water for the under-mentioned purposes:—(*a*) drinking and culinary; (*b*) cleanliness—personal, domestic, and civil; (*c*) extinction of fires; (*d*) manufacturing; (*e*) road watering and miscellaneous. With respect to the heads (*b*), (*d*), and (*e*), we believe that the present water supply is generally satisfactory; but except on rare cases this cannot be said with respect of head (*a*), nor in any case can it be said in respect of head (*c*). The importance of these two heads it is difficult to exaggerate, as on the quality of the potable water depends to a large extent the health of a vast population, and on an adequate provision for the extinction of fire depends the preservation of the largest aggregation of wealth in the world. With respect to head (*a*), we have already shown that there are in London close upon 4,000,000 of human beings who should be supplied with wholesome potable water; let us now see, as regards head (*c*), what is the mere money value of the property requiring protection from fire. This subject of fire extinction has frequently been the subject of Parliamentary consideration—in 1862, in 1867, and again in 1876 and 1877. In these later years a committee, presided over by Sir H. Selwin-Ibbetson, has made the fullest investigation into the question of the Fire Brigade and into the means of extinguishing Fire in the Metropolis. From the evidence given before that committee it appears that as much as £540,000,000 of London property is insured in the fire offices. With respect to the uninsured property there is a great diversity of opinion. No witness puts it lower than equal in amount to the property insured, so that no one gives the total value as being much less than £1,100,000,000. But other estimates made the proportion as much as one insured to four uninsured; the total value of the property, therefore, according to those estimates, amounts to £2,700,000,000. Captain Shaw's opinion, however, is, there is one-third insured and two-thirds uninsured. If he is right, then the total value of the property of London is a little over £1,600,000,000. To revert to (*a*) potable water. One of the writers of this paper is old enough to remember the wheels at London Bridge pumping up the water of the Thames as it flowed past them, and delivering it direct into the houses of the inhabitants; and even within thirty years some of the companies took their supply from the Thames opposite—what was then Hungerford Market, from the Dolphin at Chelsea, from Hammersmith, and from Kew; but year by year the river got more foul and the population became more critical. Complaint was made as to the quality, and as the companies from time to time came to Parliament for further capital to meet the increasing wants, conditions were put upon them which have resulted in all the companies who derived their sources of supply from the Thames taking that supply from above Teddington Weir, so as to be out of the tidal influence, and in the employment of depositing reservoirs and filter beds so as to get rid, as far as possible, of all foreign matter. But, in spite of all this, the public is not satisfied. Occasionally the water is declared on authority by Colonel Bolton, in his monthly reports, to be turbid, and in his last report (for June, already quoted) Dr. Frankland says that the suspended matter in the water supplied by one of the companies was full of moving organisms. Naturally, the public, even after all that has been done, are not satisfied as regards the supply of potable water. Nor do we believe that they ever will be satisfied, or can be satisfied so long as that water is derived from rivers into which is poured the sewage of a great part of the large population of the basins of the Thames and of the Lea, and also the surface drainage from the highly cultivated and therefore highly manured land of those basins. With respect to fire extinction, nothing at all has been done by the water companies beyond the giving of a supply of water at street levels, to be picked up by the pumps of the fire-engines and pumped upon the fire. Captain Shaw has said in his evidence before the late committee that his requirements, even at the largest fires (which requirements he calls very moderate), amount to no more than 2000 gallons of water per minute, capable of being played upon the fire through lengths of hose not exceeding in the aggregate half a mile—that is, through 14 hoses of 200 feet each, each hose conveying 150 gallons per minute. And yet he says that in many instances this moderate quantity cannot be obtained. It appears that the volume of water used annually in London for the extinction of fires is only 1-400th of the total supply—that is to say, not one day's water is used for extinguishing fires in the year. But it must be remembered that fires do not burn with average regularity throughout the year, throughout the day, and throughout the Metropolis, but that they break out at intervals and at particular spots, and, therefore, this comparatively small annual percentage has to be delivered, not as a regular percentage of the usual delivery, but in quantities vastly in excess, for the moment, if anything, required for the locality in which the fire may be raging. Two thousand gallons per minute is at the rate of about 3,000,000 gallons in the 24 hours—that is to say, when a large fire occurs there should be concentrated at the particular spot a rate of delivery equal to 1-40th of the whole power of the London water supply, or enough to meet the ordinary daily wants of a town of 100,000 inhabitants. Bearing these facts in mind, it is not surprising that the pipes of the companies, which have been laid with a due regard to economy of capital, large enough merely to supply the needs of the houses—these needs being at the average rate of a pint and a quarter per minute per house, or 227 gallons per house per day—should be inadequate, in many instances, to bring to the scene of a fire 2,000 gallons per minute, even when delivered at the level of the street for the services of a fire-engine. But there can be no question that to insure the prompt extinction

of fire it would be in the highest degree desirable to be able to apply an effective jet from the water main, without the intervention of a fire-engine. This has been amply proved by the experience of Manchester, Liverpool, and other towns, where there is, by gravitation in the mains, a constant high pressure, competent to deliver large quantities of water in the form of jets. This section is not one which deals with engineering matters, but we think we may be pardoned for making a few remarks upon the subject of jets. The Metropolitan Board of Works, in its desire to do that which is best for the safety of the inhabitants of London and to do nothing rashly, more than 12 months ago instructed us, in conjunction with Sir Joseph Bazalgette, to carry out a series of practical experiments upon the question of fire jets, which should put beyond all doubt the engineering points involved. We may state briefly the result of these experiments. With a very low jet, say of some 30 ft., about seven-eighths of the head or pressure effective at the orifice of the jet will be obtained, as the height of the column of water—that is to say, 40 ft. of head at the orifice would give a jet of about 35 ft. in perfectly still air; but as the heights of the jets are increased, and increased they must be, if they are to be of any service in extinguishing fires in the most valuable buildings of London, the modern buildings, which are so lofty, the percentage of which the column of water produced bears to the effective pressure producing it becomes less and less, so that for a jet to rise to a height of 80 ft. there must be, roundly, a pressure equal to 128 ft. To rise to a height of 100 ft. there must be an effective pressure of about 180 ft. Moreover, the higher the jet the greater must be the diameter of the column of water. A small jet, which will attain a respectable percentage of the head producing it, if that head be low, will be unable to cope with the resistance of the air, if the pressure be high. We do not suppose that the section will care to go into details on this matter; but we will give them as an instance a fair average jet required for London purposes. A jet that would rise 80 ft. in still air, if of one inch in diameter, would deliver the 150 gallons per minute, and would demand an effective pressure, as has already been said, of 128 ft. at the very orifice of the jet; and it might be thought, therefore, that if a pressure could be maintained in the pipes equal to 128 ft. of head, when the water was flowing, that all that was desired would be provided. But this is not so. There is the very striking and to many people very unexpected consideration of the friction of the water through the hose to be taken into account; and the section may, perhaps, little expect to be told that every foot of the usual size of hose employed by the London Fire Brigade, when conveying 150 gallons of water per minute, requires a pressure of a little over three inches to drive that water through. As a matter of fact, the 200 ft. of hose demands 53 ft. of pressure to get 150 gallons per minute through them; therefore, to obtain a jet of 80 ft. high, expending 150 gallons per minute at the end of 200 ft. of hose, there is needed a pressure at the main of 181 ft., and this pressure must be maintained while the water is flowing. We believe the section will now well appreciate why it is that if it be difficult for the water companies in many instances to deliver 2000 gallons per minute at the street level, it would become absolutely impossible for them to deliver it were its exit opposed by the 181 ft. of pressure. More especially will the section understand the difficulty when they are told that there is not one of the London companies which is bound to give throughout its district this pressure of 181 ft. above the pavement, or anything bordering upon it; indeed the obligations of the largest company but one are fulfilled by giving a pressure of only 40 ft. above the pavement—a pressure which, so far from being able to produce a jet delivering 150 gallons at the end of 200 ft. of hose, can only succeed in driving 122 gallons per minute through a hose of that length at the ground level without any jet at all. These things being so, we think that upon this point of the extinguishing of fires, London will no longer be content with the provisions, as regards quantity and pressure, which now prevail. The question now arises, how are the legitimate complaints as regards potable water and water for fires to be met and to be satisfied? There are many who suppose that the defects arise solely from the fact of the supply being in the hands of private trading companies, and who urge that if the undertakings of those companies were acquired by the governing body of the Metropolis, so as to put the whole water supply under one management, every complaint would disappear; but they would be amenable to the public because they have the best resources. That system, as is well known, is the obtaining of water for all purposes, either from the Thames, the Lea, or from wells. With the exception of the well supply, the water so obtained is, as we have said, put into depositing reservoirs and is filtered, and is thus treated whether it be used to flush a sewer or whether it be drunk, and is delivered at one and the same pressure, whether it be required at the basement of a house or for the extinction of a fire. Suppose the governing authority to pursue the same system and to obtain water from the same sources, obviously, though there might be some ecomony in management, there would be no radical change either in quality for drinking or in the quantity and pressure for fire purposes. The mere fact of Corporation ownership does not change either quality and pressure, although this simple truism is very commonly overlooked. What, therefore, would be the position of the governing authority? They would speedily find they had bought a "white elephant," the possessing of which would, under any ordinary system, compel them to set about finding some unobjectionable source of supply, so that all the water might be fit for potable purposes, and would compel them to alter the pipeage, and also to increase the height to which the water is raised that it might be available for fire purposes. It is commonly a sufficiently difficult thing to find an unobjectionable source of supply for a town of even 100,000 inhabitants: but in the case of London the difficulty of procuring 125,000,000 gallons a-day is one of the greatest magnitude. There have been, as the section well knows, various propositions for bringing the water from the Lake Districts of Wales and Cumberland by means of gigantic aqueducts to London; but, after full examination by Royal Commissions, these propositions have been rejected; and, moreover, an opinion has been expressed by those Commissions that it is not expedient the water supply of any district in England should be taken from the towns in its immediate neighbourhood to supply the wants of a town afar off. But assuming that such works could be carried out, the very projectors of them admit that their cost would be enormous. Moreover, they could not deliver the water at a height which would give sufficient pressure without the aid of pumping. The whole of the pumping expenditure, therefore, must be maintained, or if an adequate pressure is to be kept in the mains for fires must be extended. Would it be wise for the metropolitan authority to acquire at a cost which from numerous instances we could readily show to the section would not be less than £25,000,000 sterling the undertakings of the present companies when that acquisition was burdened with the necessity of forthwith discarding the sources of supply and of forthwith entirely re-arranging and modifying all the distributing apparatus and all the pumping power at an expense of at least as many millions more? We need scarcely say that, rich as London is, such outlays would never be sanctioned. But it is evident that something must be done. London must be supplied with wholesome, potable water, and it must have a greater security from fire. We have reported to the Metropolitan Board of Works, and our report is before the public, that the only practical mode would be to separate the water for drinking purposes and for the extinguishment of fire from the water which is used for all other purposes. Although, as we have said, it is next to impossible to find 125,000,000 gallons per diem of unobjectionable water, it is perfectly possible to find 30,000,000 gallons per diem, or even more than that quantity of water, which is pronounced by all authorities to be of the best possible quality for dietetic purposes—viz., the pure spring water from the chalk. This has been recognised by the Duke of Richmond's Commission in their report. Now it will be found that the most liberal allowance of water for drinking and cooking is covered by two gallons per head per diem. And by cooking we mean, not only the water used in the saucepan, but the water used in the washing of vegetables and fish, and in otherwise preparing food for cooking. Two gallons per head per diem is only 7,000,000 or 8,000,000 gallons for the whole Metropolis. But in our report we have doubled this, and have allowed 16,000,000. Our proposition is that there should be made on the high ground to the north and to the south of London reservoirs at a height of 400 feet above ordnance datum; that these reservoirs should be supplied by pumping engines, drawing their supply of spring water at distances of from 8 to 15 miles beyond the reservoirs—that is to say, in the open country; that the reservoirs should all be united by large arterial mains traversing London from north to south, and that these mains should be united by subsidiary mains. From these latter mains a service pipe would proceed to each house, delivering the water into a close vessel having a draw-off tap, and containing, according to the size of the house, from 3 to 10 gallons and filling up gradually, after having been emptied. On these mains also would be placed, at the time they were laid down, the hydrants for fire extinction. The plan we have proposed would, we believe, overcome every difficulty in providing for the important requirements of *(a)* the potable and *(c)* the fire extinction water; and even if the property of the water companies were acquired by the governing body, this plan, as it seems to us, is the only feasible one by which the present complaints could be satisfied. If this be so, why should not the plan be at once carried out, leaving the

question whether the companies should or should not be acquired by the governing body for after consideration? The two things are distinct. The acquisition of the water companies would be strenuously resisted. It would probably involve years of Parliamentary warfare, and during the whole of this time London would be left where it is as regards its water supply. After very careful calculation we have estimated that the total cost of the whole of the works necessary for carrying out this separate supply of potable water, under sufficient pressure for extinguishing fires, will not exceed £5,500,000, and this includes the house fittings and also the hydrants. The annual cost attendant upon such a capital expenditure and upon the working of the undertaking will at first sight appear to be large, but, when contrasted with the expense which would be involved in meeting the improved fire requirements alone under any ordinary system, that cost will be found to be considerably less. The evidence adduced before Sir H. Selwin-Ibbetson's Committee showed a very curious state of facts as regards the small annual money expenditure for the preservation of London from fire as compared with other places. For the protection of the sixteen hundred millions of property in London there is accorded an annual sum of a little under £80,000. Of this £80,000, £48,000 arise from a halfpenny rate, £19,000 from a contribution by the Fire Offices, at the rate of £35 for each million insured, £10,000 from the Government, and £2,750 from miscellaneous sources. Let us see now what proportion this sum of £80,000 per annum for the preservation of London from fire bears to the sums expended in other large towns, and the best way of comparing will be by taking the expenditure at per thousand of the population. London, with a population of, say, 3,500,000, and an annual charge of £80,000 spends £22, 17s. per thousand. Paris, with 1,986,000 of population, spends £100,000, or £50, 6d. per 1,000. New York, with 1,098,000, spends £249,600, or at the rate of £233, 14s. per 1,000—more than ten times the sum spent in London. Chicago, with 550,000 of population, spends £111,093, or exactly £202 per 1,000. Numerous further instances might be quoted, all of which would tend to show that London, although undoubtedly the most important city in the whole world as regards population, wealth, and magnitude of the interests involved, is the one that spends relatively the least for the extinction of fire. That London, in such circumstances as these, should suffer so little as it does from disastrous fires, we think must be admitted to be due to the excellent organization of the Fire Brigade, and to the unwearying diligence and assiduity of Captain Shaw. The London Fire Brigade under his management has gone on from year to year coping with and even mastering the increase in their labours arising from the increase of London. But it is clear that there is a point beyond which it is impossible for them to protect the Metropolis unless in some way their powers are increased. This point is certainly reached now, and in fact has been reached for some time past. The report of Sir H. Selwin-Ibbetson's committee clearly recognises this, for they have recommended in their report that the limit of the rating power for fire purposes should be doubled, thus adding nearly £50,000 per annum to the present income. That committee further recommends that hydrants should be fitted to mains and services wherever there is a constant supply, and should follow the extension of that supply; this, as appears from the evidence, would involve an expenditure of £750,000 at least, which, at 3½ per cent., would cost £26,250 per annum. They also recommend that the water system should be consolidated in the hands of a public authority, which, in dealing with the questions of constant supply, pressure, and pipeage, should be bound to have regard not only to the convenience of consumers, but also to the requirements for the extinction of fire. This alteration of pipeage means the outlay of an unknown sum, certainly not less than one million, or an annual charge of £35,000. It further means the increase of pumping power at an increased cost, stated in evidence before this committee, of £150,000 per annum; but it has also been shown by the engineers of the water companies, and we entirely agree with them, that it would be idle to pretend to maintain such a pressure until the house fittings were all altered to suit it, and this could not be effected for less than £3,600,000, which, at 3½ per cent., amounts to £126,000 per annum. These are the sums involved in the recommendations of Sir H. Selwin-Ibbetson's Committee, who conclude their report by saying that "effect should be given by the Legislature to these recommendations." Let us now contrast the financial results of the two plans:—Purchase of the undertakings of the water companies, £25,000,000, at 3½ per cent., £875,000; alteration of pipeage, £1,000,000, at 3½ per cent., £35,000; annual expenditure of the companies in 1874 was £447,529; say diminished, owing to the concentration of management, £47,529; leaving £400,000; increased cost of pumping for higher pressures required for jets, £150,000; interest at 3½ per cent. on cost of hydrants, £26,250; interest on cost of altered house fittings, £126,000—total, £1,612,250; equal to about 16½d. in the pound on the present rateable value of the Metropolis. We should mention that we have not included among these items the extra £50,000 a-year expenditure on the Fire Brigade contemplated in the report of the Committee, because we are convinced that if a hydrant service with proper pressure be given, not only need there be no increase in the annual charge for the Fire Brigade, but the existing expenditure will be very considerably lessened. The annual cost of the plan we propose is—interest at 3½ per cent. on £5,500,000, £192,500; working expenses for pumping and management, £32,500—total, £225,000. Equal to about 2½d. in the pound on the rateable value of the Metropolis. The gross income of the water companies in 1874 was, as we have stated, £1,137,000, or about 11½d. in the pound, making, with the 2½d., a total of 14d. in the pound, as against 16½d., or a saving in mere money of 2½d. in the pound, or close upon £25,000 a year. But it will be seen that by the dearer process, no improvement whatever has been made in the quality of the drinking water, and that nothing has been attained except a better provision for the extinction of fire, whereas by the cheaper plan not only has this latter object been attained, but the difficulty with regard to the most important question of all, that of potable water, has been entirely overcome.

MACHINERY IN THE UNITED STATES.

NECESSITY calls forth, if it does not create, all the powers of ingenuity that are in human nature. To make the best use of resources, the best use of time, the best use of circumstances, are lessons of great value, and these usually proceed from the stern admonitions of necessity. A vast region of untold wealth in material and in nature creates ingenuity; the people of the United States are by their very surroundings compelled to be inventive and shrewd. In the matter of machine-making they are most remarkable; they are likely to compete with us more closely year by year. A general review of what is doing there has been collected by Mr. Anderson, and it is to set before the reader an abridgment of his observations that this paper is undertaken.

It must be borne in mind, that while the nation itself is only a hundred years old, its machinery is less than a quarter of that period, and their people proceed in the right way while using their skill. They cannot be said to be as a rule copyists; they are marvellous in the art of ingenious devices and methods of saving labour—faculties of the utmost value where labour is a very expensive article, and natural resources are practically unlimited. The recent exhibition at Philadelphia displayed most conspicuously the enormous producing-power of the States. In this department there were more than a hundred exhibitors, and each with a large display. In the vast array there were machines for all purposes—small arms, ammunition, sewing-machines, clocks, watches, specimens of every branch of machine-making and engineering, of excellent workmanship and finish. The country is eminently adapted to the production of large quantities. Everything there is great, and industries which here grow up in one man's hand, and in two or three generations become the property of a company, there start as companies. The concerns are born great. And yet there is not the rudeness and coarseness which might be reasonably expected. For instance, the watch-making industry is becoming one of the most important of any one, and Europe is feeling its influence in a manner that is not at all agreeable. American watches bid fair to be eminent for quality, as they are distinguished by the smallness of their cost. Lathes and tools required for watchmaking operations are in infinite variety, and the best judges declare that no mere words can convey an idea of their high standard of excellence; they must be carefully examined, handled, and felt. What the Whitworth standard gauges are to true circles and exact dimensions, these lathes and tools are to all forms required in the manufacture of watches. Add to this, great convenience in arrangement and fitness to produce the parts of a watch so exact, as to be almost interchangeable.

The next in the same exquisite style, but applied to a heavier class of machinery, was the tool collection of Ames & Co., of Chicopee, the same firm which made the gun-stock machinery for England, and which is now well known in Europe. The lathes and other machines by this firm were finished as accurately as standard gauges. No higher place can be given; but the comparison points to a standard of quality not easy to reach, rarely seen, but much wanted for many branches of art. An original and special machine, in the same style of finish, for

tracing a copy and transferring the design, carving, or engraving, as in profiling or die-sinking was exhibited. It was a treat to be allowed to feel and handle this machine, so as to be able to appreciate the universality of its slide movements, the slides fitting as tightly as the gauges referred to, yet so softly and easily, that scarcely any pressure was required to move them in any direction.

Firms have their special characteristics. One making heavy engineering tools is unnecessarily careful to have some of the parts of such brightness of polish as to rather offend good taste, making the steel look almost like silver. The tools are of sterling worth, but of tawdry appearance. Another makes a class of tools in which precision is the leading characteristic, and of the lighter class of lathes and machines for special purposes where the interchangeable property is an essential requirement. Another, which excited general admiration, was the invention of Mr. Corliss, whereby the teeth of the centennial bevil-gearing were shaped—one of the finest special tools for originality of design now constructed. Ugly in appearance, it exhibited great refinement in the details; the required mathematical lines for which were traced from a steel copy. The accurate numericai division was obtained from the periphery of a surface wheel, 15 feet in diameter, by rigid means which held the entire system fast as a rock, and which could be adapted to any division that might be required in practice. It had a manner also of double-keying the dividing-wheel upon its axis, and had various adaptations in the index-plate, in order to secure accurate adjustment. But the visitors were more struck with the part which carried the planing apparatus. It consisted of a swinging radial arm or frame, held in equilibrium, which traces the steel copy, and guides the cutting instrument while shaping the teeth. Its position is always parallel with the required line of cut, and its centre of motion is the mathematical point in which all the converging lines of the cones of bevil-gear terminate. The mechanism employed to set in action the cutting instrument was a rack with teeth, not rigid in the usual manner, but always conforming to its required position in relation to the driving pinion.

The famous house of W. Sellers & Co., of Philadelphia, set up forty distinct machines, many of them of gigantic proportions, but all beautifully finished. For instance, a steam-hammer shown by this firm was remarkable for the elegance and originality shown in several of its details, in the form and arrangement of the hammer proper, for the manner in which the hammer-head is secured to the hammer, affording great convenience in fixing and unfixing. Also for novelty in the mode of working the steam-valve and several marked improvements in connection therewith. One of the machines was for producing flat surfaces, and although a new conception, was here developed into a practical tool for the engineer. Sir J. Whitworth was the first to develop the true surface-plate system, which has hitherto been arrived at by planing and scraping, depending on volition for the ultimate perfection of a true plane. In this new idea, the true surface of a perfect table is transferred to other surfaces, by moving the latter over a grinding instrument in the middle of, and on the the same true plane.

The most important feature is this, that the surface to be made true, may be of any degree of hardness, even chilled cast-iron or hard cast-steel, thus opening up a new field of endless application for slide-valves, and for many parts of tools and machines where extreme hardness is a virtue. In lathes of all kinds, this firm is remarkable for mathematical accuracy, and all were furnished with original devices, which enables a zealous workman to develop the produce of the lathe to its utmost capability, yet without physical effort. By the introduction of an under V within the bed, the shifting head is always drawn to the same straight line, thus avoiding the necessity of a tight fit within the shear, and its consequent disadvantages. Their system of feed motion is admirable, a simple combination of discs, whereby the feed rate may be altered from one extreme to another, or to any intermediate point, by a mere touch.

Their planing-machines are famous in Europe, and are now being copied in all countries. One of the largest ever made, which planes automatically in three directions, is now under construction at Philadelphia for a Russian arsenal. These planing-machines are distinguished for directness in a transmission of power. The trammels which have hitherto kept engineers to spur or bevilled gear are broken through; they employ the old gear only when it is the best for the purpose, but if not, they devise a new and special gear going straight to the point, in whichever direction it may be. This is shown in several of their machines, besides the planing, and naturally raised controversy among experts. The devices employed to give the feed motions at the proper point, and to avoid a struggle between the open and cross belts at the reversing moment are most ingenious, and were much admired by the judges. One of the most striking features of the American section is the variety of special tools for all sorts of purposes. In this they take the lead One example was a lathe for brass work, employed in making the water injector for steam boilers; considered as a combination of clever devices to accomplish a definite object, it was a fine tool. It enables an intelligent man to accomplish more work in turning, boring, screwing, or fitting, than is possible in an ordinary slide lathe, which is intended for general work. Besides, it is less dependent on the workman for accuracy.

It was the general opinion among engineers at the Centennial, that this class of machinery will have to be more and more resorted to, as competition intensifies, because it reduces cost of production and raises quality. Messrs. Sellers' gear-cutting machine is also well known in Europe. It is entirely and strikingly automatic. It receives its work and performs it to the end, shifting from one division to another, until completed, no attendant workman being required meanwhile. Even the mathematical curves of the circular-cutting instrument, including the curve of clearance, are all predetermined and embodied in a machine, irrespective of any future intelligence having to be exercised in their production; still more, the curves are such, that as the cutters wear through use, the fresh lines presented at each sharpening are ever mathematically true as pre-determined.

The Exhibition was rich in everything that relates to smithing and forging. All classes of articles seemed to be made by transfer from copy. A profusion of drop hammers of various systems of construction, adapted for different classes of work, were shown in abundance.

Trip hammers, peculiarly American in design, were exhibited in action. Padded most ingeniously with india-rubber, they were driven at 500 blows per minute with impunity. With a single heat they can draw down a piece of steel one inch square and six inches long into a rod five feet in length; as the heat went down at any part a few seconds under the tilt brought it back to redness, so that it seemed as if the drawing process could be prolonged indefinitely. It was in the workshops, however, that the earnestness of American smithing and tools was seen to the best advantage. Where articles have to be repeated, as in making the interchangeable parts of railway bridges, there is scarcely any skilled handiwork required. Coloured labour brings forward the bars of iron on trucks or otherwise; the ends of the bar are heated in a furnace, and then put into a set of dies which are surrounded with, and worked by hydraulic pressure. A touch of a handle by a skilled attendant, causes the dies first to hold firmly, and then to set up or shorten and squeeze the hot iron into form. If there is a hole to be made, a taper mandril passes through the dies, driving the red hot iron into every crevice of the steel mould, the whole operation occupying only a few seconds. In connection with these hydraulic forging machines, an accumulator is used, and the cylinders being of large diameter, the hot iron is like soft clay in the hands of the potter, and pieces of work that would occupy a good smith with a couple of strikers for half a day, are made perfect at once and at a small cost; the chief expense being in the setting up of the machines, and not in the working.

It is also to be observed, that American drilling machines are undergoing a new development. Spindles are now nearly balanced, the preponderance being on the side of the counter-balance which is usually in the interior of the framing. With the counter-balanced spindle, the drill does not drop in passing through, thus avoiding fracture of drill. Spindles are arranged for a quick free movement, both into and out of the hole, the automatic or hand feed only coming into play when drilling commences. Another change, nearly universal in the American machines, is the introduction of an index to show depth o penetration, without having recourse to the withdrawal of spindle. Other machines are arranged for being previously set for a determined depth, the machine having the automatic faculty of withdrawing when it reaches the required distance. This advantage, combined with the self-clearing property of the twisted drill, enable more and better work to be done, and although apparently trifles, yet each one points to greater efficiency and economy.

A new idea is now prevalent in America in regard to the manner of driving drilling machines, which seems likely to alter their system of construction almost entirely. They find that with a given quantity of power, more work is done with a belt alone than with the usual system of wheel-gear intervening. This fresh light dawned upon them unexpectedly. A certain article required in great numbers was at first drilled in geared machines entirely. During an emergency belt drills was extemporised as a makeshift, when it was found that the workmen, on the new tools, made more piecework wages than the other men. At first the advance in production was accredited to the superiority of the new men, but on transposing them, it was found to be due to the belt system. On further experiment, it

was found that spur-geared machines only, were superior to machines having the customary bevilled gear in addition, Accordingly, the belt unaided is superseding the gear system in the best workshops, for all drilling where repetition is involved.

Another important feature in their workshop economics, is the manner of sharpening drills. The drills are not held in the hand, but in an instrument which presents the drill to the grinder in a manner that insures positive truth in the cutting edges, besides mathematical accuracy in the angles, thus rendering the drill more efficient, and affording more and better work than is practically attainable by the rule of thumb system at the grindstone.

The grinding agent in all, was the corundum or emery wheel, chiefly the latter, and in none did precision depend on the skill of workmen.

Of good-working machinery, as might have been expected, the quantity exhibited by the United States at the Centennial Exhibition was enormous. There were upwards of 80 exhibitors, each with a large collection, the greater number showing progress both in design and execution. The competition in this class of machinery is intense; yet the greater number of the larger exhibitors gave away valuable illustrated books, showing the minutiæ of all their machines, as if regardless of competition. They rarely copy from each other in vital parts, and the points in which they severally excel can only be copied by a master hand, already overflowing with new devices of his own. The impression is left upon the minds of European visitors, that American competition in machine tools will soon be upon us; but that the competition will not be in regard to price, but rather for high quality and productiveness, and the capability of doing more work with a given expenditure on labour. As an illustration of the rapid changes which are now going on, that of dovetailing as employed by the carpenter or cabinetmaker may be mentioned. At the opening of the Paris Exhibition in 1867 there were several saw combinations which approximately supplied the want, but their details were incomplete. After several months had passed, a new machine invented by Mr. Armstrong arrived from America, which all admitted to be perfect, its only fault being the cost. This machine was taken up by many of the best firms in all countries, England included, and at least half a dozen Armstrong machines were exhibited at Vienna in 1873. I did not observe a single one at Philadelphia, but saw five other machines without any similarity to each other or to the Armstrong. Their peculiarity lay in their simplicity and reduced cost. Another marked feature running through this class of tools consists in imparting to them the faculty of adapting their own arrangements to peculiar or unexpected circumstances. As an example, a remarkably clever machine was in daily operation, dressing the exterior surface of wooden hoops for casks. The hazel sticks or rods, with all their crooks and lumps, were fed into the machine and passed instantly through it. The province of the machine is to feel their exterior form, and then to dress the outer surface in conformity therewith, but not to disturb the fibre. This is a sort of duty that might be supposed to require judgment to do it properly. The necessary intelligence is embodied in the machine, and the work is done to perfection. It was also to be observed, that machines are having entrusted to them the duty of sharpening their own cutting instruments when they become blunted. This confidence was first exemplified in Sweden, and was shown at Vienna in 1873. At Philadelphia there were several examples, but in none was it done with better grace than in the Swedish case. At the Centennial Exhibition, however, there were some interesting examples of machines having the faculty of taking care of their more delicate members. One of the large band-sawing machines was shown in operation with a band saw, little more than a steel thread, doing work that seemed impossible, it was so fine. The secret of its not breaking was due to an understanding that exists between the fragile steel thread and the overhead carrier pulley. The pulley takes entire charge of its own inertia, and thus relieves the saw from its influence both at starting and stopping. The mechanism to achieve so much was simply the intervention of a light slipping medium. There were shown some interesting examples of automatic tools that encroach on the province of the sculpture in wood. Busts of Shakespeare and Dickens were being made to order, either in boxwood or planetree, at a small cost. In such machines, the form and likeness came by transfer from an iron original which had simultaneous movement with the wooden block. The cutting instruments made from 8000 to 10,000 revolutions per minute, thus giving a fine surface, scarcely requiring more finish than a rub with sand paper to obliterate the marks of the tool.

This Exhibition was remarkable for the number of efficient machines for working all sorts of stone. The chief feature of almost all of them is the employment of the diamond as the cutting agent. Former Exhibitions have been renowned for their display of diamonds as articles of ornament. At Philadelphia diamonds were in equal profusion; but they were used for the teeth of saws and drills to fashion stone to useful purposes. In regard to rock-drilling appliances, the greater number are similar to those employed in Great Britain. The stone-sawing machinery, however, is in advance of anything previously attempted, and most probably will form a new point of departure. The several articles exhibited, divide themselves into two classes—for reciprocating vertical or horizontal sawing with frame, and for circular sawing, the latter predominating. Most varied were the mechanical arrangements, but in three main points all unite. Every saw tooth is tipped with a diamond; an enormous concentration of power and velocity is employed; and, lastly, a deluge of water runs upon the point of action, to keep down the temperature and to subdue the shower of sparks. Much refined ingenuity is displayed in some of the methods devised for setting the diamonds, so as to secure them in such a thin body, and at the same time to give them a good rear support quite out to the cutting surface of the tip. The saws are about 6 feet in diameter, and the diamonds are of the dull Brazilian variety.

In past times England has been the nursery ground of the manufacturing system; her factories have been visited; her cotton and textile manufactures have been copied by all nations. We have no doubt she will retain that proud distinction. It must, however, be admitted, that in various ways we can learn of Americans, and in their versatile faculty, the adapting means to ends in the most singular and effective methods. In those they are without a parallel.

MAJOLICA.

RECENT fashion has changed this old word into Maiolica, without assigning any reason, or leaving us to imagine any that is deserving of mention; for this changing of terms argues a pedantry or a conceit that had better not be seen, much less exposed, when we feel that the offenders mean no particular offence.

Several papers have appeared recently on the subject of pottery, and it is one of those charming occupations or studies which have never lost their attraction among persons of taste and culture. The notes on Persian Derby, China Japan, and latterly on the clay itself, seem to demand some observations on a part of this class of artizan and artistic occupation, distinguished for the excellence of its specimens, and the history that is attached thereto.

Majolica means enamelled and painted earthenware. The term had gone out altogether, and is now revived with somewhat indistinct associations. *Faience* is the word stated to be the proper modern equivalent, but the explanation is very unsatisfactory. No doubt that the French, who are, especially in olden times, authorities in matters of taste, and employ definitions with special accuracy, used this in a very general sense, which included all descripticns of glazed earthenware, so far as to be almost as comprehensive as our English word—crockery.

Modern methods are, however, reviving or instituting a more restricted use; and it is to that use we will address ourselves. Vessels made of coloured clay, and colated with a white opaque varnish, so as to resemble *faience*, before that term became general, in which, notice, we must of course derive the best examples from the ancient Italian, notably those in the South Kensington Museum. These are the chief, but any notice must include choice specimens of this species of porcelain not exactly open to classification.

Majolica came from Majorca and Sicily, as has been proved by a passage in the work of Julius Scalizer, who wrote in the first half of the 16th century. He speaks of the porcelain made at Majorca as not being inferior in form or brilliancy to those imported from China, and "even surpassing them in excellence;" it is said that such excellent ones are now brought, that they are preferred to the most beautiful utensils for the table. We call them "Majolica," changing one letter in the name of the Bealeric island, where we are assured that the most beautiful are made. Uzzano, in 1442, writing a treatise on commerce and navigation, speaks of the manufactures of Majorca and Minorca, particularly mentioning *faience*, which, he adds, "had then a very large sale in Italy." Whether the Moors taught the islanders, or *vice versa*, we know not. It went to Italy as the market, and the factory remained in the islands; but it became essentially an Italian art, for Italy had

its imitative and idealistic craftsmanship. Even in the date 1300 a decorative character prevailed under the lords of Pelsaro, and it is to us moderns a teaching that should be regarded. Those men, whom it pleases a lesser grade to deride, with all

Fig. 1.

their terrible works, ever worshipped education and art. Engaged in strifes, we happily know only by truthful evidence, in words, they had for their subjects those who could take red clay (and there is plenty of it in England) and made it of pottery, which, covered with their thin coating described by San Giovanni served for the groundwork of their "marvellous works." They baked the vessel in part, and then applied a covering of lead glaze, sending it immediately to the kiln for final purposes,

Fig. 2.

a la Wedgewood and Minton. This overlaying of an opaque white substance became the starting-point of majolica; but was not that overlaying of an opaque white substance known to Persia 500 years before? and did not the lingering unwritten tradition—not even oral, bring it to these? The colours were yellow, green, blue, and black. But look at the result! The ideas are traditional, but the result is a new creation. The lead glaze, being soft and influenced by the air, gave the material a metallic iridescent brightness. It was applied to the external decorations of churches in those hollow dishes which Passeri says collected in their cavities beautiful effects from the rays of the sun.

Fig. 3.

The process of making majolica may be thus briefly described. The body is mere common clay or terra-cotta. When the piece is finished on the wheel, and has taken shape, it is thoroughly dried and burnt, which makes it, in technical language, "biscuit." The glaze is generally applied by immersion, and it is made of substances pulverized and mixed with water to the consistence of cream, into which the piece to be covered is dipped. The "biscuit," being porous, absorbs the moisture and leaves the glazing to adhere as a fragile soft coating, to be covered with enamel colours. Herein is displayed the wonderful facility of the ancient painters on majolica. The outlines are drawn by a mere stroke, and it is perfect. When painted it is again fixed in a protecting case of terra-cotta, and then the crude glaze fuzes into a glossy, vitrified enamel; the painting sinks into and is in-

corporated therewith, and a brilliancy of tint ensues that could not have been expected.

Early specimens of 14th century majolica have Arabesque patterns in yellow and green on a blue ground, and any candid student must give precedence to Robbia, who was born in 1388, and became a distinguished sculptor. He worked in marble and bronze at Florence and Rimini, but disliking his occupation he modelled in terra-cotta, and, after many experiments, produced the white enamel coating that can never be dissolved, and a specimen is now at South Kensington (Fig. 1). Tiles and altar-pieces in enamelled terra-cotta of his production abound, and he had many students who, loving the work, did according to the master's example. He did not confine his practice to white, for near Florence there is an altar-piece at San Minianto of blue ground, white figures, golden colour, and with green garlands.

Robbia died in 1481 at a great age, having invented and perfected the new style of decoration. None have excelled him. He had assistants whom he loved, and a nephew, from whom we have many good works; but the simplicity and purity of style belonging to the master is not perceptible in the subsequent work of his nephew. The master loved white and blue; the boys strove to use all sorts of colours. They interpreted the application of yellow he often made to give them a license he would never have accorded.

Majolica is indebted for its perfection and illustration to the liberality of the house of Urbino, who, for 200 years made it their special care, and gave to the world an imperishable result. Warriors were men of letters, and men who guarded art, and developed the hidden capacities of the earth, both material and immaterial. These dukes excelled in learning, in painting, in conquest, in patronage: they became poor through their profusion, and the art they spent their all upon sank into irretrievable deterioration when the resources of the nobles failed. The glorious collections became the property of Ferdinand de Medici.

There is a class of majolica known as Raffael-ware, from the beauty of design and from the undoubted guidance of that immortal hand. Most probably his scholars did the work from the master's drawings, who, just as engraving reached its highest point of excellence, allowed his plates to be copied even for

Fig. 4.

earthenware ornamentation. The Urbino dish, with Raffaelesque grotesques is a fine illustration (Fig. 2).

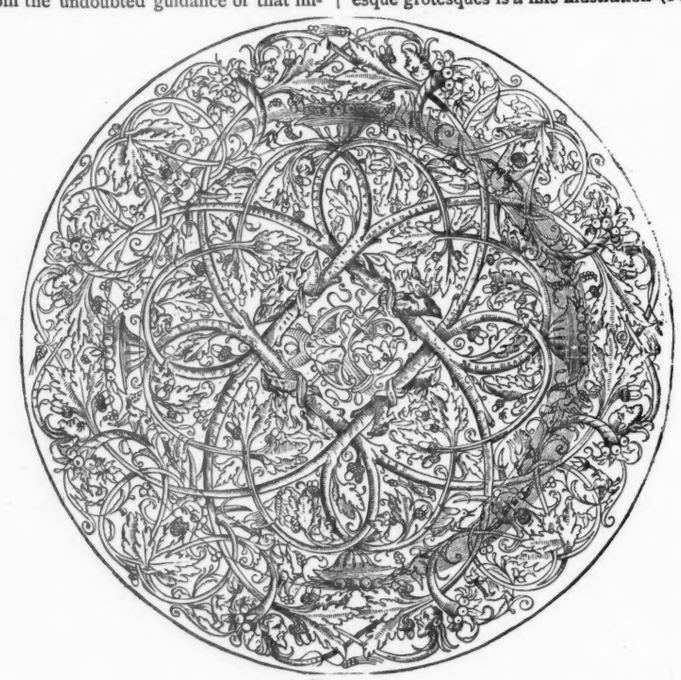


Fig. 5.

The Mezza majolica lacked design and drawing, but it excelled in the beauty and perfection of its colour and enamel glaze, wherein the yellow and white colours have the metallic lustre of gold and silver. The iridescence has never been surpassed. The ruby of Gubbio, made of two colours—blue and yellow, with certain mixtures, produced the most striking effects under the marvellous painting of the artists, although in detail there is a certain deficiency of culture. Here is a lustred altar-bowl, made there by Giorgio, Fig. 3, and Fig. 4, a deck-dish. The one is radiant with its classic beauty, and the other is an illustration of his decorative manner, which consisted in foliated scrolls (much wanted in our modern styles) and other ornaments, terminating in dolphins, human heads, trophies, masks, &c. His work had no succeeding hand of his skill, and a quarter of a century after his death the art fell into premature decay, so much that the proper composition and manipulation for producing lustres became a lost secret. The general decadence of Italian pottery of the artistic description followed rapidly, and the Duchy of Urbino ceased to be the home of Majolica ware and industry.

But there were other places in Italy where good majolica was made in the sixteenth century, and especially at Venice; indeed,

there is every probability that the art had its votaries there. There is a very fine dish in the collection at the South Kensington Museum of the date 1540, which would almost prove that

Fig. 6.

the art at that time had reached its highest point of perfection, Fig. 5; and in Fig. 6 we give another from the same collection of a vase of great richness and excellence.

[We beg to thank Messrs. Chapman & Hall for the beautiful illustrations of this article.—ED.]

LEAD FOR PENCILS.

ROBERT PLOT wrote in the seventeenth century that "the mineral substance called Black Lead—(our Common Lead being the true Black Lead, and so called in opposition to Tin, which is the White Lead), found only at Keswick in Cumberland, and there called Wade, or Kellow, by Dr. Merret, Nigrica Fabritis, from its use in scoring, as the Rubrica Fabritis or the Red Ochre is,—it is certainly so far from having anything of metal in it that it has nothing of fusion, much less ductility; nor can it be reckoned amongst the stones, for want of hardness: it remains, therefore, that it must have place among the Earths, though it dissolve not in water as most earths will, except stiff clays and ochres; it seeming to be a sort of close earth, of very fine and loose parts; so burnt that it became Black and Shining, discolouring the hands, as all the ochres do; whence the most proper name . . . may be Black Ochre of a strong sort, as there are strong sorts of Red and White Ochres as well as Clay."

Plot spent the greater part of his life in researches of different kinds, and has no more than the authority of a fussy, acute observer; he is not entitled to any rank among scientific men, although his papers are in the Philosophical Transactions of the Royal Society.

Gesner, who wrote in the sixteenth century his book on fossils, printed at Zurich, says that people had pencils for writing which consisted of a wooden handle with a piece of lead, or, as he believed, an artificial mixture called by some *stimma Anglicanum*. This is the earliest notice of what is our black lead pencil.

Cesalpinus supplies a better description in his works, written a quarter of a century later. He says of this substance that it was a lead-coloured shining stone, as smooth as if rubbed over with oil; it gave to the fingers an ash-grey tint, with a plumbeous lustre; and pointed pencils were made of it for the use of painters and draughtsmen. It was called Flanders Stone, because the Italians obtained it from the Netherlands.

Imperato about the same time calls this "black lead" *grafio piombino*—a much more appropriate designation, and says that it is much more convenient for drawing than pen and ink, because the marks made with it appear on a white ground most vividly, and also, on account of its brightness show themselves on black; and also because there is no difficulty in rubbing them out when desired, and they will not perish if undisturbed, and because if one wishes he can draw over them with pen and ink, which cannot be done where lead or charcoal have been used.

Modern mineralogy has fixed the position of this substance as pure carbon, *i.e.*, "a non-metallic element, the crystalline and opaque descriptions, graphite or plumbago, being used for pencil-making. Its specific gravity is 1.2, and the hardness is between 1 and 2 of Mohr's scale. It conducts electricity nearly as well as metals, has a metallic, steel-grey colour, produces a black, shining streak on paper, and is used not only in pencil-making but in a less pure form for crucibles." We know it to be carbon; also, that when exposed to great heat, it consumes and leaves scarcely any ash. Its formation is probably like coal, of vegetable origin,—certain gases producing a decomposition that, finding egress by veins in rocks, have ultimately formed this substance. We cannot in the laboratory obtain exactly that product which nature has the means to accomplish, but we can trace the course by which the wondrous and secret changes have come, and modestly think we can imagine the beginning. We cannot make coal from wood, but we know wood can be carbonised, and in two ways—wet and dry. If dry, the carbonisation is soon accomplished; if wet, the process is very slow.

These processes have at any rate been in progress for ages, and the whole earth bears witness to the simplicity and universality of an unknown law which has operated to the creation of this material in every place. We in England, at Borrodale and Keswick, in Cumberland, had the finest result in that the material and the market were in one land; but since the northern mines have been partially exhausted, we have seen, by the rise and success of Faber's pencil factory in Germany, that other countries have an equally good material, and that, whether they are satisfied with smaller profit or have such an abundance of the mineral and can obtain less costly labour,—in any case, the market is supplied better at diminished expense to the consumer.

Mount Borrowdale is nearly 2000 feet high, and the entrance to the black lead mine is about half way up its side. Years ago a wholesale system of robbery was carried on there by the waifs of the neighbourhood, stealing the earth of which the mine is the treasure-house, and disposing of it to persons who would sell the manufactured imitation at half the price demanded by the proprietors. Guards were placed, but by force or connivance they were continually disarmed, and the mine robbed. At the entrance to the mine stood a building having four rooms upon its ground-floor, and one of these had an opening for the workmen's transit to the works below, where in a dressing-room the miner's habiliments, above ground, remained in exchange for the working dress. The secret realised £100,000 a year, and tempted the "loafer" to listen to offer for the stuff, if he could get them cheap; and he did get them cheap. Brookman and Longdan's pencils, guaranteed by Banks, sold in the trade at 4s. to 8s. per dozen, and these smugglers offered them through queer channels in exact imitation of name, &c., at 1s. 6d. all round. The mine was shut up. Another vein has been struck since the closing, and a rich parcel is hoarded: the proprietors decline to part with it except in limited quantities per annum, but that is now believed to be exhausted being bought up.

Plumbago being obtainable everywhere, and other hills beside that of Borrowdale, having all the elements of the Cumberland, but not in blocks that could be cut into parelleloids as the famous pencils were composed of, there arose a necessity to utilise the waste or disqualified matter in order to keep alive the pencil trade for Cumberland. Selecting from Scotland, Ceylon, Cornwall, and Norway, what specimens could be obtained, a series of experiments followed, not only in reference to those, but to the refuse at home. Mr. Brodie purified it by a process of his own. 1st. When coarsely pulverised it was mixed in an iron vessel, with double its weight of sulphuric acid (commercial), and seven per cent. of chloride of potash, and the whole heated until there was no more chloric oxide evolved. The whole underwent washing, drying, and heating. When red hot the grains exfoliated, and the mass swelled until all the particles were minutely separated. It was then put through a smoothing process of the utmost perfection, and the purest result, so far as the material went, was the result.

There had been a great accumulation of dust in the manufacture of the genuine Cumberland pencil from the sawing, the fragments, and the waste, and how to utilise this valuable and pure material caused much concern. It would not burn; it was not metal; it was not stone; it was only fit for pencils. Mr. Brockedon of London took out a patent in 1843, one clause of which provides for the difficulty. He sets forth in his specification:—

"In cutting black lead much powder or dust thereof is produced, a given weight of which is of small value when compared with a like weight of black lead of equal weight, of equal quality; hence it is desirable, that to cause the powder or dust of black lead to be again rendered solid, so as to allow of its

being again cut for the making of black lead pencils. . . . I subject this powder to pressure in dies in order to solidify it into masses or blocks of 2¼ in. long, and 1¼ in. wide, and ¾ in. thick, or any other convenient size. I find that this powder can become more certainly solid by pressure and the withdrawal of air." He then tenders his drawings and claims his right.

This system exactly met Mr. Brodie's trouble. He had acquired a powder from a purifying process, but he wanted the compressive agency invented by Mr. Brockedon before his invention could be of public or private good. Brockedon had learned that pressure in the abstract has a singular peril. The man of science may go too far—he may break his own apparatus. Hence arose his second idea of withdrawing the air and operating in a vacuum. After he had brought his mass together by as much pressure as could be safely applied, he cased the little bricks in very thin adhesive paper, in which he made one hole for air-escape when under the receiver. The air-pump soon did its work; the little hole was glued over. After a short interval, the press again did its work, and a perfect block rewarded the workman—a block as solid as that made by nature.

But while Mr. Brodie effectually developed his conception and produced genuine material from very varied sources, through the means provided by Mr. Brockedon, it needs no discoverers to suggest that such a machine could be used for the purposes of the fraudulent, as well as for the production of cheap goods that were worth their money, however little that might be. The pencil manufactory became a scandal and a disgrace to the trade. Pencils were made of earth little better than pulverized stone—hard and gritty, colourless and pointless; and, indeed, some found it worth their while to place an inch of good stuff at one end and fill up the cavity with rubbish, and none,—not even the best,—ran the lead continuously through. Artists in the provinces were plagued beyond measure. Trade marks were imitated, and deception became chronic. The German house of A. W. Faber, pencil makers, sent over to England a comparatively small supply, and it went through the wholesale stationers into the country houses at a price which at 3d. left half profit, and could be easily supplied at 2s. a dozen. The lead went through. They were evidently made either of the block system, or a skilfully composed paste which for its co-adhesion had no deleterious substance or ingredient. Their pencils soon found a general favour. Great varieties followed both in shape and quality, and extra fines were introduced for special purposes. Then came the pocket pencils, the coloured ones and the great variety for which the house is famous.

But to return to England. The pencil works at Keswick consisted, a few years ago, of a high building of several stories, under which was a water wheel on the river Greta. A stack of cedar stood in the yard, and the sawing business went on. First into plank, and then by circular saws into little pieces ready for grooving. The grooving-engine had two saws, one cutting the slips into narrow square rods, and the other forming the groove and cutting to size; adjoining that was a circular saw cutting the cover,—that is, the upper part of the pencil that covers the groove filled with the lead.

There are two kinds, therefore, of black lead: that from the mine, and that from art.

In the former,—all the bits, with their surface scraped, are glued to a board to fix them for sawing, and the saw cuts them into thin slices, or scantlings. These are handed to the fitter who takes these rods and sticks them into the grooves. From him the "fastener-up" receives them: he glues the covers on. When dry they are ready for rounding, which is done by revolving planes, or tools fixed to a bench; and a man can do with that machine 700 dozens a day. They are then put to a smoothing plane and rubbed with fish skin by girls. In due time, ends and lengths all finished, there comes the stamping, and that is done by girls at the rate of 200 a minute, and they are sent off to be bundled.

But without any knowledge of the German secret we are inclined to think their pencils come under the category of artificial pencils, and that they contain something analogous to china clay in quality, but not in colour. M. Conte gave the world his process at the close of the last century, and avows it to be a a mixture of clay with black lead. From that he acquired aggregation and solidity: first by placing the clay in tubs through which river water passed, and in his own way produced a clear and soft sediment, which after straining through linen he manipulated upon.

The plumbago, or black lead, he reduced to a fine powder in the manner before stated, and placed it in a crucible until white hot. Then comes the mixing. If you want hard pencils, put in more clay: if soft, put less clay, and don't make the mixture too hot. Mixing requires technical skill: two of lead to three of clay is the general rule, but that depends in its application to the kind of pencil you wish to obtain. Having this pulverised brick it is usual to make experiments to see whether the mixing is truly effected. If successful, the remaining clay is introduced and the paste ground with a muller till it acquires the consistence of dough, when it is made into a ball, placed on a stand under an inverted glass in a basin of water.

Grooves in a smooth board, which has been boiled in grease, similar to the parallelo-pipeds are then made, only a little larger, to allow for drying: into these grooves the paste is put by a small druggist's spatula, and another board is clamped over them. After this has been done, and the contents atmospherically dry, the mould is placed in a warm iron heater, and subsequently burned out. These rods are set up in a crucible, and surrounded with charcoal-powder, fine sand, or sifted ashes, and sent to the furnace where heat is applied by Wedgwood's pyrometer according to the hardness the owner requires. The crucible is then removed and allowed to cool with its contents.

There are various methods of treating this artificial material. If you want architectural pencils these rods should be greased. If for shading and fancy drawing they must not.

We have only referred to the general outline of an interesting subject not much noticed, and may return to it.

THE INTERNATIONAL LAW ASSOCIATION ON PATENTS.

ANTWERP has been the scene of an important discussion on the subject of Patents granted by law, and while the entire subject is for the present session in abeyance, much if not every thing depends on the extension of knowledge that shall concentrate opinion before the Parliament resumes its legal functions next year. These Patent Laws must be assimilated; they are as diverse as the nations at present, and the position is vexatious if not scandalous. Without venturing to offer many observations indicating our own opinions we will endeavour to set before the reader the points at issue as they have come before men who have made the subject one of formal study. At the Hague conference in 1875 Mr. Lloyd Wise read a paper containing the following suggestions:—Where a patent has been applied for in one country, subsequent publication of the invention during a limited period should not necessarily prejudice the original applicant's right to patents in other countries; he should, however, be required to specify the countries in respect of which he desires to retain the option of obtaining patents, at the same time that he applies for his first patent. A notification of the reservation should be entered on the records of the country in which the original application is made, and a like notification should accompany every document concerning the invention, officially remitted to each of the countries reserved, the applicant to be deemed to have abandoned his right to ask for a patent in any country so reserved, when not exercised within the period prescribed. As the fundamental object of a Patent-law is to induce the early communication of new inventions, the original applicant should, except in case of fraud, be regarded as the first inventor. Every application for Letters Patent should undergo examination limited to the questions whether the specification is clear, and whether the invention is open to objection as being contrary to morality, or wanting in novelty, regard being had to prior publications in the patent office of the country. Should the result of the examination as to novelty be unfavourable to the applicant, he should, nevertheless, be entitled to a patent, subject to the insertion in his specification of an acknowledgment of the existence of the prior matter, with a clear statement of his claim. Patents should be refused only in cases of fraud, or when the invention is contrary to public morality; all other points should be left to the adjudication of the courts, only in the event of the validity of the patent being called in question. There should be no publication of any report or opinion of the examining authorities, with regard to any application for a patent, saving only reports of proceedings in disputed cases. Provisional protection should be granted for twelve months, at a nominal cost, to allow time not only for perfecting the invention, so that it may be properly and fully described in the final specification, but also for obtaining, if needful, the co-operation of capitalists. Every patent should be granted for the full term, which might well be 20 years, subject to periodical payments of—say £50 at the end of the 5th year, £50 at the end of the 10th year, and £50 at the end of the 15th year. In the absence of prior publication or notification of reservation by an independent inventor, the validity or duration of a patent granted in any one country should not be in any way affected by the circumstance of a patent of earlier date having been granted elsewhere for the same inven-

tion. The patentee should be at liberty from time to time, on payment of a moderate fee, to add to his original patent any improvements he may have made, which clearly involve the use of the main claim granted to him under the original patent. A patentee should not be compelled to put his invention in operation within any specified period, as he will naturally endeavour to secure a return as soon as possible; nor should he be precluded from importing into one country, where he holds a patent, articles manufactured in another. Where the patentee does not himself manufacture in the country where he holds a patent, he should be required to grant a license, in consideration of a reasonable royalty, to any responsible manufacturer desirous of working the patent in that country.

In consequence of this paper a committee was appointed to examine and report not only on these suggestions, but on the patent law generally, and their report was submitted to the Bremen Conference in 1876, in which they set forth that they considered it abundantly established by experience that it is for the commercial interest of every nation to grant protections in the shape of patents to inventors. Referring to the resolutions of the Vienna Congress of 1873, the committee recommended that in any action taken by the association in favour of an assimilation of the patent-laws, the second resolution passed at Vienna should be adhered to as a basis, though it might be necessary to supplement the principles there enunciated by some other provisions. In particular, it might probably be found desirable to embody some of the suggestions contained in Mr. Lloyd Wise's paper, especially as to the extent and character of the preliminary examination, and the course to be adopted in the event of an adverse report. The Bremen Conference having received the report, a more numerous committee was appointed, with power to add to their number.

The additional members included Sir William Thompson, Mr. Brown, M. P., Messrs. T. Aston, Q.C.; Woolly, Secretary to Institute of Naval Architects, Field, C.E.; H. Merryweather; D. Murray; Major Crease, and Admiral Selwyn, and of course the former members, Mr. Hinde Palmer, Q. C., and five others. The modifications made will readily appear.

A sub-committee having been appointed to consider the German Bill, their report was forwarded to Count Munster, for transmission. Though two or three of the suggestions made by the committee were adopted, the Act finally passed, with comparatively few modifications. The committee regard this law as a great improvement on the many conflicting systems of the patent law and practice previously in force in the various German States, and they approve the principle of annual progressive fees, the placing of foreigners and German subjects on the same footing, and the practical manner in which the question of infringement is dealt with. Some of the provisions of the Act are, however, disapproved especially the publicity given to applications for patents, with the view, apparently, of inviting public criticism before the patent is granted. This is considered to afford a wide opening for opposition, on the part of powerful manufacturers, to the introduction of new inventions which might possibly injure their immediate interests, although benefiting the general public. The committee also protest against the clause providing that articles of food and medicines should not be subjects of patents, as discouraging inventions in these branches of economic science, especially as to this category of exceptions have since been added substances produced by chemical process. They hold that these exceptions set aside the first principle upon which all Patent laws are based, viz., that it is in the interest of the State to grant temporary exclusive privileges to inventors, in order to encourage the exercise of that enterprising industrial genius on which the progress of civilisation and commerce so largely depends.

With regard to preliminary examination, the original Bill has been improved by the omission of a paragraph which, it was feared, would enable the examiners to entertain objections grounded upon the apparent impracticability or inutility of an invention. The committee regret, however, that it is still left in the discretion of the Commissioners of Patents to reject an application which they deem to be wanting in novelty. As this question is one so difficult to decide, the committee urge that the applicant should be allowed, notwithstanding an adverse opinion of the examiners, to take out a patent, if he be willing to make an acknowledgment in his specification of the pre-existing publications pointed out by them. Such a patent would be taken out at the applicant's own risk, the question of novelty in his claim being left for subsequent decision.

The term of fifteen years established by the German Bill cannot be considered as satisfactory, seeing that in Belgium patents are already granted for twenty years, in the United States for seventeen years, and in England there is a power in the Privy Council of extension to twenty-eight years. Experience shows that many of the most important inventions have required as much as ten or twelve years of outlay and loss, before becoming remunerative to the inventors. While the committee approve of the mode in which the fees are to be levied, they regard the total amount as excessive, seeing that the fees to be paid in respect of a fifteen years' patent amounts to 5,300 marks, whilst in England, where the fees have long been complained of as absurdly high, a fourteen years' patent only costs £175 (3,500 marks) in France a fifteen years' patent costs 1,500 francs (£60, or 1,200 marks), and in Belgium, where the cumulative system of payments is also in force, a fifteen years' patent would cost only 1,200 francs (£48, or 960 marks), and a twenty years' patent, 2,100 francs (£82, or 1,640 marks). In the United States, a seventeen years' patent costs in Government fees, only 35 dollars (£7, or 140 marks).

The committee remark that the English Bill, introduced by the Attorney-General into the House of Commons early in the session, was in many respects a great improvement on the Bills introduced by the Lord Chancellor, but its details were objected to and the Bill withdrawn. The French Committee submitted for consideration at the Paris Congress to be held next year and for present discussion, they contain the following proposals :—

1. A temporary privilege of sufficient duration to ensure the remuneration of their labours and outlay, should be accorded to inventors.

2. This period may extend to seventeen years, the first two being regarded as years of experiment.

3. The fees should be payable by progressive annuities, the first being as small as possible, and the last not exceeding twenty times the first.

4. The specification should be kept secret for a certain period; the patent should bear date from the deposit of petition; and this should take place simultaneously at the authorised office, and at the consulates of the various foreign nations.

5. At the expiration of the secret period, the specification should be published, when the patent should be granted, provided it be not opposed to public order, and, also, during a further fixed period, there be no opposition. In the event of opposition the case should be decided by a specified tribunal; and the granting of a patent should be no bar to opposition.

6. Patents of importation should only be granted to the inventor or his representatives.

7. Patents for the same invention in several countries should only be granted for an equal period. In other respects, the several patents should be perfectly independent of each other.

8. The principle of expropriation on the ground of public utility is applicable to patents. There is no reason to admit obligatory licenses. Patents should be declared void if, after a certain delay, the inventors or their representatives do not work them, the causes of non-working being, however, left to the consideration of the courts.

9. The introduction by the patentee of similar articles manufactured abroad should only be permitted under the condition of reciprocity resulting from treaties or the laws.

10. The mere fact of the transit through a country of a patented article manufactured abroad should not be regarded as an act of introduction, except so far as the trade-mark laws apply.

11. For giving publicity to inventions and designs, it would be well to adopt a system of cheap and rapid reproduction, by printing or otherwise, so that they may be placed in detached sheets at the disposal of the public.

These reports and documents are in the hands of a joint committee of French and English members of International Law. Its association will embody a legislative project that shall commend itself to the Houses of Parliament next session. There we propose to leave it for the present. It is a momentous subject.

THE DESTRUCTION OF FORESTS.

WITHOUT in the least degree sharing the alarm common to a considerable class of scientific men, leading them to protest against the destruction of forests, which has been going on for the past 50 or 100 years in various parts of the world, it would be foolish to give no heed to the arguments or fears of those who make such subjects their study. Algeria happens just now to be the topic of discussion, and will doubtless receive the practical attention of those who preside over its affairs. Consul Playfair during a tour through the country reports a general decadence and gradual exhaustion of the soil which he attributes to the forestal destruction that has been proceeding with increased violence during the past hundred-and-fifty

years especially in Tunis and Algiers, and undeniably a gradual change of climate is manifest. At one time large districts were covered with underwood or timber preventing injurious evaporation and attracting or condensing the atmospheric moisture by means of heavy dews or rain.

These clearings began about 1845 and are progressing with dangerous rapidity, and the rainfall began to diminish in 1855. In the seventeen years prior to that date it was only on two occasions more than 1,000 millimetres, and on eight occasions more than 800. In the twenty-one years which followed it has only twice reached 800 millimetres, and the present year is almost the worst of all, and something very like famine is imminent in Western Algeria.

The question, not only of restoring to the country the wood that it has lost, but of providing a supply of a constantly decreasing article, is the most important one that can engage the attention of the statesman or the colonist. If this had to be effected by planting such trees as oak, ash, pine, &c., all of which are indigenous to the country, it may well be imagined that a speculator would hesitate before engaging his capital in an enterprise which could hardly yield him a return in his lifetime; but with Australian trees, which grow as freely in Algeria as in their native country, he may expect to cover his expenses in ten or twelve years, and after twenty or twenty-five to obtain as great results as could be realised by oak-forests of a century's growth. It is hardly more than fifteen years since the first eucalyptus trees were introduced into Algeria by M. Ramel, and very few indeed exist in the colony of a greater age than ten years; even now it can hardly be said that any attempt has been made to grow them on a great scale. There are many other Australian trees, suited to almost every condition of soil, found in Algeria, such as the beautiful acacias, or wattles, the grevilia, casuarmas, &c.; these are, no doubt, destined to play an important part in the *reboisement* of the country; but it is the eucalyptus alone which merits to be planted over extensive areas for the sake of its timber. There may be parts of Europe where this tree could be cultivated as well as in Algeria—though that is very doubtful; but hardly anywhere is the price of land sufficiently moderate to enable it to be grown with a certainty of profit. As a rule wherever the orange tree flourishes, so does the eucalyptus. In Algeria it attains, in six or seven years, the same dimensions as the oak does in twenty, and, in its twentieth year, it may be expected to furnish such logs of timber, for shipbuilding or other purposes, as could not be furnished by an oak tree under 100 years old.

There are trees which, even in Europe, under certain circumstances grow with great rapidity, but the marvel is, that growing with the rapidity it does, the eucalyptus should produce at the same time hard and dense timber. A short time ago, wishing to send a eucalyptus tree of four or five years of age to England for experiment, it was found impossible, on account of its great length, to put it into a boat to convey it to the steamer. The boatman naturally decided on towing it alongside, but the moment he put it into the sea it sank to the bottom, and divers had to be employed to raise it. When properly seasoned its specific gravity becomes less, and it then floats on water. To illustrate the quality of the timber, Consul-General Playfair instances the use of a vessel, the *Marie*, of 230 tons burden, which entered the port of Algiers with a cargo of timber in 1875. It was built in Melbourne in 1848, the hull being of blue gum (*Eucalyptus globulus*), and the interior fittings of red gum (*Eucalyptus resinifera*). At twenty-seven years of age it was still rated by the *Bureau Veritas* of the first class.

The first trees were planted in Algeria in 1862, and M. Trottoir gives certain pecuniary results he thinks obtainable from a hectare of land planted with eucalyptus. Thus a plantation of one hectare, which gives appreciable results in the third year, will yield in the tenth a minimum of 7,000 frs., and in double the time it ought to produce four times the value. This estimate may be exaggerated, but even allowing a liberal margin for pardonable enthusiasm, the result cannot fail to be most remunerative. But to arrive at the best results with eucalyptus they must be planted in the best land, and for the first year at least be carefully cultivated. Thus treated they may be expected to realise immense returns. For instance, the average yield of a hectare planted in cereals in Algeria may be estimated at 250 frs., and, without taking any account of the years when such land must of necessity remain fallow, the total produce in twenty years may be stated at 500 frs. During those twenty years the cost of cultivation, the value of seed, the transport to market, &c., may be considered as equivalent to the cost of planting the same area in eucalyptus, tending the trees, and finally cutting them down. According to M. Trottoir's statistics the timber would then have a value of 26,000 frs., or for the sake of being well within the mark, say 20,000 frs. If the cultivator has to remain a long time without any return for his money, surely the result is worth waiting for. The time during which these trees occupy the soil may be divided into two periods of ten years each, the first the period of growth, the second the period during which the ligneous products are condensed and consolidated. If, during the first period, the land is kept clear, and the same amount of culture is given to the trees as would be given to a vineyard, the cost, calculating 5 per cent. interest on the sums successively expended, might amount, in round numbers, to 1,000 frs. During the second period no care of any kind would be required. Under the circumstances, there is every reason to suppose that the trees would make as much progress in 20 years as they otherwise would in 30. The cost of this extra care would amount to 1,000 frs., and the profit to 13,000 frs. According to the tables of Cotta, a hectare of land produces 450 cubic metres of oak in 100 years, the value of which, at 105 frs. the metre, amounted to 47,235 frs. The same quantity of eucalyptus wood might be produced in twenty years, and would realise 20,000 frs. This sum of money, placed at compound interest for 100 years, would realise the enormous sum of 816,800 frs. The number of species of eucalyptus is great, but for the purpose of commerce, two or perhaps three species only should be cultivated. The first, the *Eucalyptus globulus*, or blue gum, is best suited to warm positions, deep, fresh, and moist soil. The second, *Eucalyptus resinifera*, or red gum, resists drought in a remarkable manner, and should be used in poorer or drier soil, or at greater altitudes than the other. It is hardly probable, however, that either of them will thrive well at a greater altitude than 200 or 300 metres above the level of the sea. The third species, which promises well, is the *Eucalyptus colossea*, but hitherto our experience of it is limited, and we have not sufficient data on which to calculate its rate of growth.

There is another point of view from which the cultivation of eucalyptus must be regarded, namely, its action in improving the sanitary condition of unhealthy districts, and in dissipating miasmatic influences, which created such havoc amongst the colonists in the first years after the conquest. To place this subject as far as possible beyond doubt, an inquiry was instituted by the Society of Physical and Natural Sciences at Algiers, under the presidency of Dr. Bertherand, and reports were received from thirty localities. The spots best suited to the growth of the plant on a large scale, and the price of the land available for the purpose, is another subject worthy of consideration. To ensure the commercial success of the scheme the trees must be planted on a line of railway, and as close as possible to a station. The soil ought to be rich and deep, and there ought to be sufficient water available for irrigating the trees during the first year, not too frequently, but once when they are planted in the autumn, and twice or thrice during the course of the subsequent summer. They will grow in the driest soil, but their growth is infinitely more rapid when planted under the above conditions. The locality which fulfils these conditions best is the plain of the Metidja. Between Algiers and Blidah, on the line of rail, it is hardly possible to obtain land for less than 500 to 700 frs. the hectare; some has recently been sold for 1,000 frs. Further from the railway it may be had in some few places for 300 frs., but the cost of transport would neutralise the saving. In the plains of Chelif and the Mina there is an enormous quantity of land which may still be obtained for a merely nominal price. It would be an immense boon to the country if some of this were planted with eucalyptus, but the changes of profit to the cultivator would not be so certain. The soil is hardly inferior to that of the Metidja, but the hydrometrical conditions of its climate are very different. The range of hills stretching westward from Miliand cuts it off from the sea breezes, which always afford a certain quantity of moisture; rain is more scarce, and the farmer can hardly hope for more than one good year out of three. From Affreville, where it commences, to Oran, is a distance of about 300 kilometres. It is traversed by the most important river in Algeria, the Chelif, which rises in the Sahara aud falls into the sea near Mortaganem. Other suitable spots are likewise mentioned by Consul-General Playfair. Along the line of railway from Algiers to Oran, considerable numbers of eucalyptus have been planted. Where this line passes through the Metidja the trees have grown most successfully, but in the Chelif they have failed in almost every case. It is true that they have not been tended in any way; they have merely been planted, and left to their fate. In and around villages in this plain they have thriven better, but never so well as in the Metidja, while, in the marshy plain of the Macta, conceded to M. Debrousse, which at first sight seems a typical position for them, they have not done well at all. The reason of this is, that the land is not yet ready for them, it has lain in a state of marsh for centuries, the subsoil is saturated with salts, and the more the trees are watered after being planted, the sooner the capillary attraction brings the salt to the surface, and kills the trees or checks their growth.

On a careful consideration of the whole subject, the Consul-

General is more convinced than ever that no culture in Algeria offers such prospects of success as the eucalyptus, if the cultivator can afford to remain for a considerable time without any return for his capital, that in the long run it will be more economical to purchase land for the purpose at 600 frs. a hectare, than at 60 frs., but that to ensure success the experiment should be made close to a line of railway, and in a comparatively cool and salubrious position.

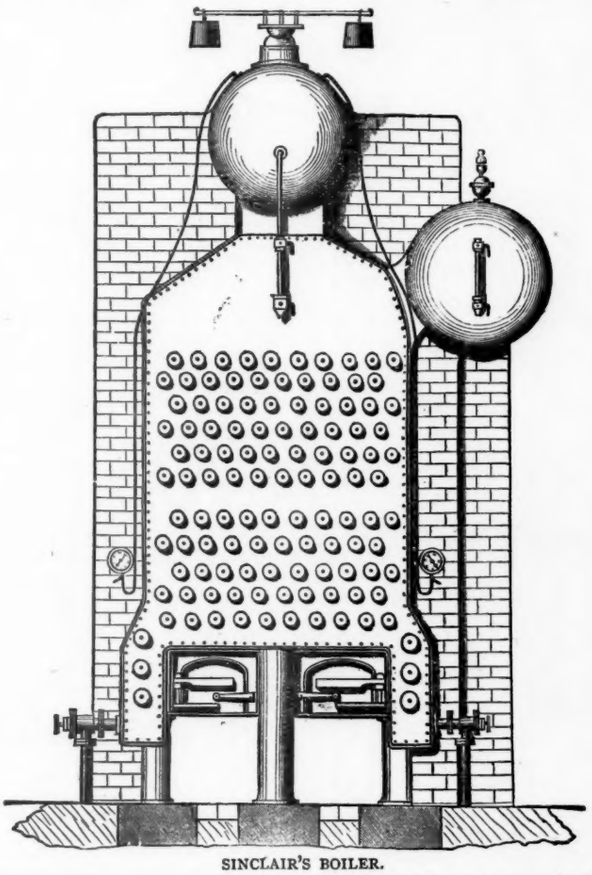
MR. FLETCHER'S REPORT ON THE ECONOMIC EFFICIENCY OF MR. SINCLAIR'S NEW PATENT WATER-PIPE BOILER AND MESSRS. BERTRAM'S NEW ENGINE, AT MESSRS. CRAIG'S PAPER-WORKS, DALKEITH.

THE Sinclair boiler consists of a number of water-pipes slightly inclined to the horizon, and laid in rows one above another; these pipes running at each end into a flat, stayed waterspace, placed nearly vertical, and opening at the top into two cylindrical vessels, 4 ft. in diameter, and 16 ft. 9 in. long, which run longitudinally over the stack of water-pipes, and serve the purpose of separators for the steam and water. It may be pointed out that in this arrangement all the water-pipes are below water-line, which is not always the case in water-pipe boilers. This boiler contains 115 water-pipes 11 ft. 9 in. long, 100 of these pipes having a diameter of 4 in., and 6 of them a diameter of 5 in., while the length of the fire-grate is 6 ft., and the width 6 ft. 7 in. Thus the heating surface of the boiler is 1507 square feet, and the area of the fire-grate, 39·5 square feet. The accompanying diagram gives a front view of Messrs. Sinclair's boiler.

The engine is of horizontal condensing construction, having one cylinder only, which is steam jacketted, both in the barrel and at the ends, fitted with a Dack's cut-off valve, regulated by a high-speed governor of the Porter type. The engine has no throttle valve, but is regulated entirely by the cut-off valve, the compass of which extends from zero to three-quarters of the stroke of the piston. The engine has a stroke of 3 ft. 6 in,. a diameter of piston of 30 in., and runs at about 52 revolutions per minute. The air-pump is 20 in. in diameter. The clearance and chamber-room at each end of the cylinder is as follows:—

	Cub. in.
Capacity of main steam-port, 18 in. transversely × 2¼ in. longitudinally × 31 in. length of passage	=1255·5
Capacity of cover of cut-off valve	= 150·0
Capacity of main slide valve—one end only	= 345·0
Clearance of piston at end of cylinder 30 in. diameter × $\frac{5}{16}$ in.	= 220·6
Total clearance and chamber room at each end of cylinder	=1971·1

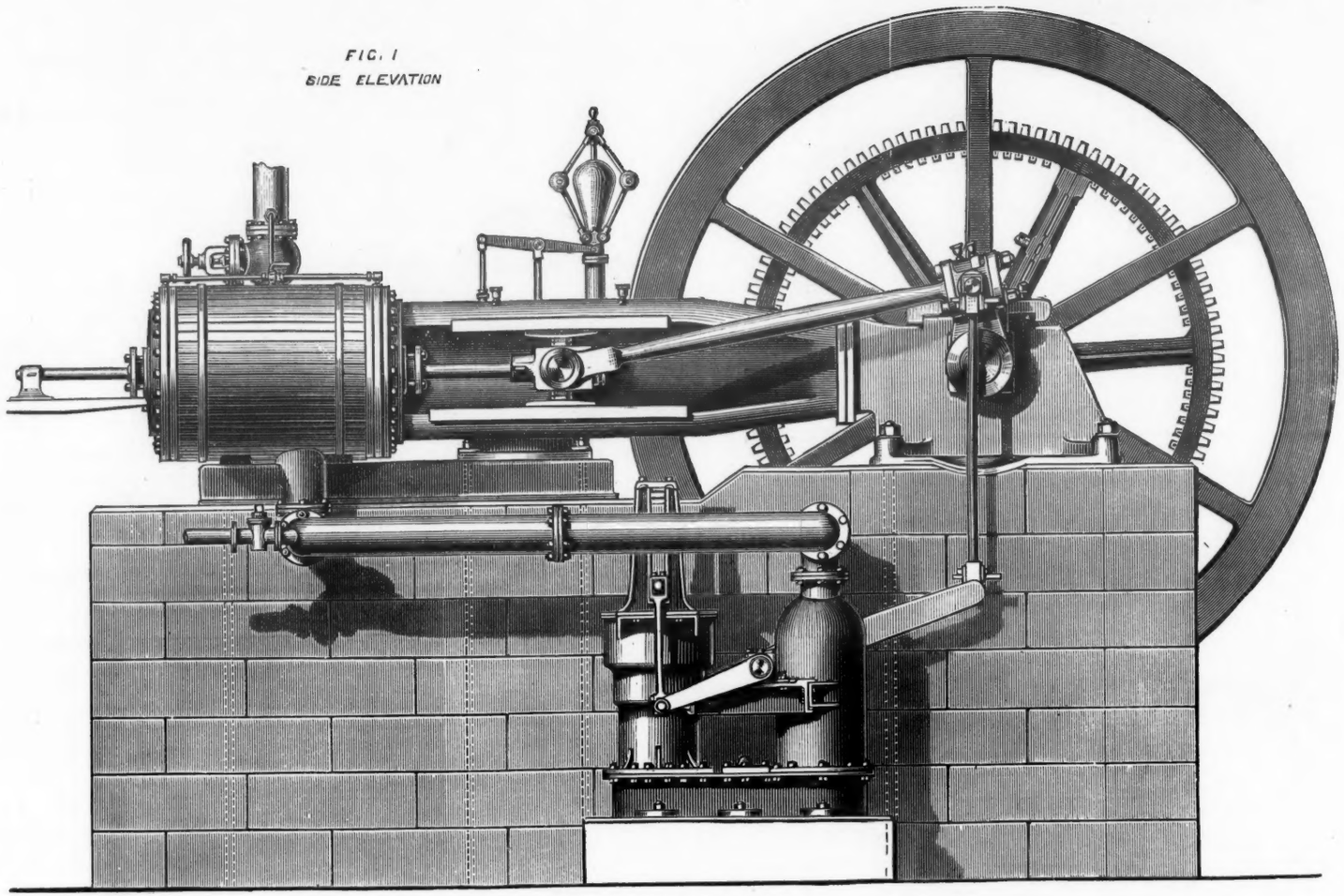
Thus the steam-ports have an area equal to one-seventeenth of the piston, while the total chamber-room of the steam-passages and piston-clearance at the end of the cylinder is one-fifteenth of the capacity of the piston-sweep of one stroke. The steam-pipe connecting the engine to the Sinclair boiler is 61 ft. long, the first 23 ft. being 7 in. in diameter, and the remainder 6 in. in diameter. Between the junction-valve on the boiler in this case and the stop-valve on the engine there are seven elbows, as well as an intermediate valve. The steam-pipes connecting the engine to the nearest Lancashire boiler, to which reference will be made in the course of this report, is 70 ft. long, the diameter being 6 in. throughout. Between the junction-valve on the boiler in this case and the stop-valve on the engine there are seven bends. In both cases the pipes were substantially covered with Fleming's composition.



SINCLAIR'S BOILER.

In conducting the experiments, indicator diagrams were taken about every half-hour from both ends of the cylinder by means of two Richard's indicators, one fixed at the front end of the cylinder, the other at the back; also all the coal burnt was weighed, and the water pumped into the boiler measured. In addition to this, the overflow from the hotwell, as well as the discharge from the steam-jacket, was measured, and the temperature of the injection and hotwell frequently taken. This

FIG. 1
SIDE ELEVATION



MR. BERTRAM'S ENGINE.

PLAN OF VALVE
WITH ONE EXPANSION CUT OFF
VALVE & COVER REMOVED SHEWING
STEAM PORTS THRO MAIN VALVE

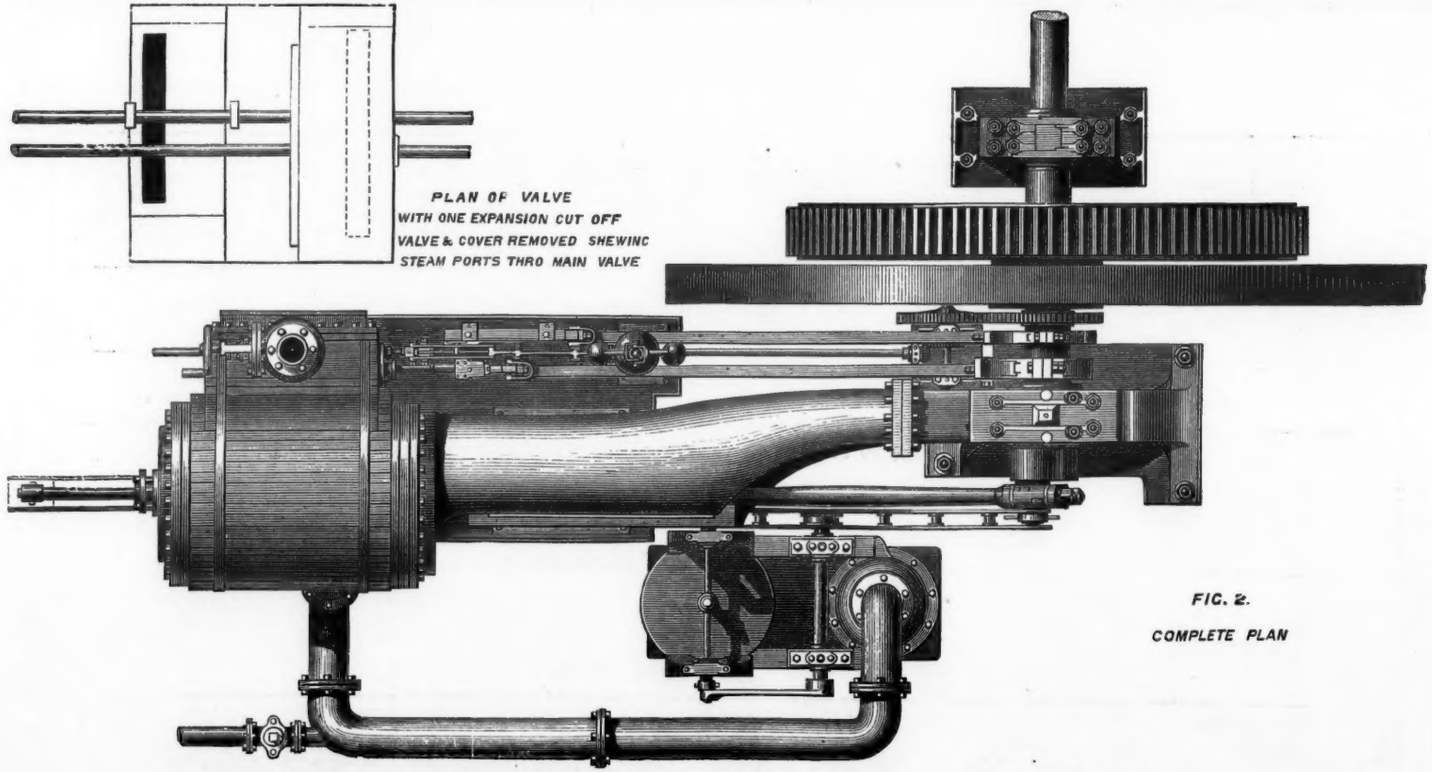


FIG. 2.
COMPLETE PLAN

FIG. 3
HORIZONTAL SECTION
THRO VALVE CHEST

SCALE OF DETAILS
3 FEET

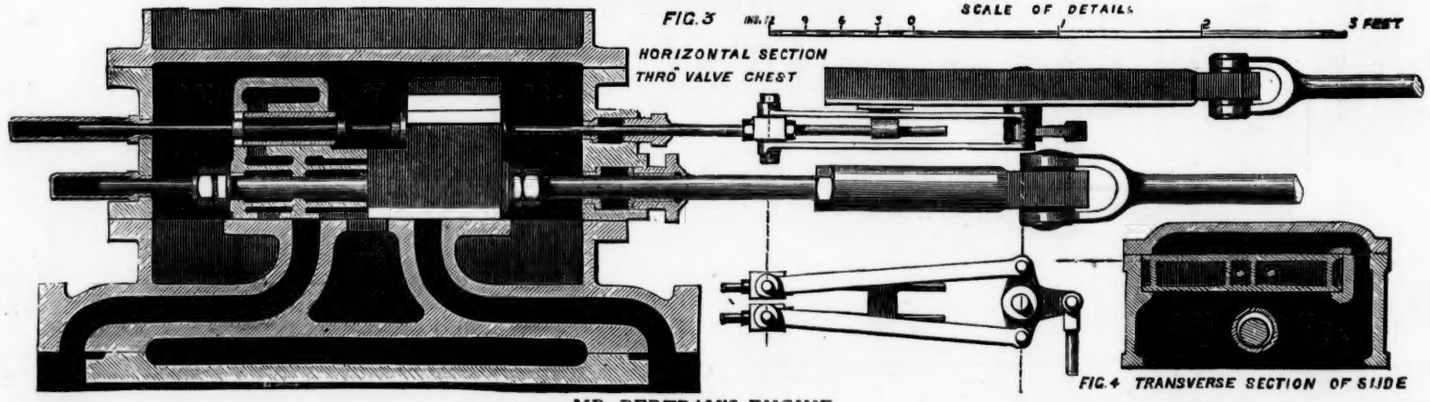


FIG. 4 TRANSVERSE SECTION OF SLIDE

MR. BERTRAM'S ENGINE.

was done in order to ascertain the units of heat carried off to waste by the hotwell per I. H. P. per minute, and thus to arrive more minutely at the economic efficiency of the engine, according to the system recently brought prominently under public notice by Messrs. Bryan, Donkin, & Co. The way in which the feed-water pumped into the boiler and the overflow from the hotwell were measured may be given somewhat more in detail, as follows:—The feed-water was measured in a tank 4 ft. square by 4 ft. deep; it was fed to the boilers by means of a donkey-pump placed immediately over the measuring-tank, the suction-pipe

TABLE I.—GIVING A SUMMARY OF THE RESULTS.

Index No.	Experiments. Date.	Length.	Boiler. Pressure in Boilers.	Boiler. Description.	Coal. Description.	Coal. Quantity burnt. During trial.	Coal. Quantity burnt. Per hour.	Engine. Indicated horse-power.	Engine. Coal per indicated horse-power.	Feed Water. Temperature. Tank.	Feed Water. Temperature. Economiser.	Feed Water. Quantity Evaporated. During trial.	Feed Water. Quantity Evaporated. Per hour.	Feed Water. Water per I. H. P.	Economic Results. lbs. of water evaporated per lb. of coal.	Economic Results. Water evaporated from and at a temperature of 212° per lb. of coal.	Economic Results. Units of heat per lb. of coal.	Temperature in the flue beyond damper.
		hrs.	lbs.			lbs.	lbs.		lbs.	Fah.	Fah.	c. ft.	lbs.	lbs.	lbs.	lbs.		Fah.
1	Wednesday, Feb. 7,	6	55 to 60	Sinclair	*Scotch*—Marquis of Lothian	3136	522·67	288·8	2·767	90·59	223°	456°	28500·	11·87	9·387	11·316	8904·56	400°
2	Thursday, Feb. 8,	7	55 to 60	Sinclair	*Welsh*—Lord Duffryn	3954	422·	295·68	3·156	83·65	183·84°	505·33	31583·12	11·87	10·669	12·855	10931·78	800° and upwards.
3	Friday, Feb. 9,	7	35 to 40	Lancashire	*Scotch*—Marquis of Lothian	5936	848·	175·3	4·836	80·6	Not used	551·33	34458·12	7·87	7·246	8·902	6491·5	450°
4	Saturday, Feb. 10,	7	30 to 35	Sinclair	*Scotch*—Marquis of Lothian	4592	656·	163·9	4·00	88·8	Not used	531·33	33208·1	7·59	7·244	8·73	6524·9	800° and upwards.
5	Monday, Feb. 12,	4½	30 to 35	Lancashire	*Scotch*—Marquis of Lothian	3752	833·7	176·5	4·793	85·22	Not used	355·	22600·	7·82	7·489·	9·22	6734·9	

being carried down to within a few inches of the bottom of the tank. On this suction-pipe a scale of feet and inches was painted, so that the amount of water drawn out of the tank could at any time be noted. The rule was, not to empty the tank nearer than within six in. of the bottom of the suction-pipe, and always to fill the tank up to a fixed point, so as to give a depth of 2 ft. 6 in. at each charge. Tables were prepared giving the number of charges pumped into the boiler at each experiment, with the hour at which the tank was refilled every time. This mode of noting is thought superior to that of simply making a score as often as the tank is emptied or filled, as a mistake may readily be made through inadvertence in such a system, while a record of the time on every occasion on which the tank is refilled affords a check by the regularity of the inter-

TABLE II.—GIVING A SUMMARY OF THE RESULTS OF THE TRIALS OF MESSRS. BERTRAM'S ENGINE.

1	Experiment. 2	3	Cylinder. 4	5	6	7	Mean pressures of steam. 8	9	10	11	Economic results. 12	13	14	15
Index No	Date.	Length.	Diameter	Length of stroke.	Number of revolutions.	Steam jacket.	In engine-room at time of indicating.	Initial in cylinder.	Terminal in cylinder.	Mean in cylinder.	Indicated horse-power.	Units of heat carried off by hotwell and steam jacket per I. H. P.	Water per I. H. P.	Coal per I. H. P. calculated on a basis of 9 lb. of water to 1 lb. of coal.
		Hours.	Inches.	ft. in.	Per min.		Above atmos.	Absolute.	Absolute.	Absolute.		Per minute.	lbs. per hour.	Per hour.
1	Wednesday, Feb 7	6	30	3 6	53·6	Steam on.	53·3 lb.	58·97 lb.	11·84 lb.	23·5 lb.	188·8	304·17	25·15	2·794
2	Thursday, Feb. 8,	7	30	3 6	52·8	Steam on.	52·3	58·02	13·0	24·72	195·7	377·6	23·05	2·561
3	Friday, Feb. 9,	7	30	3 6	52·5	Steam off.	34·7	41·88	14·0	22·28	175·3	488·5	28·08	3·12
4	Saturday, Feb. 19,	7	30	3 6	52·5	Steam off.	31·8	39·78	12·52	20·82	163·9	480·63	28·94	3·215
5	Monday, Feb. 12,	4½	30	3 6	49·8	Steam on.	31·0	41·48	14·14	23·64	176·5	438·22	27·69	3·076

val. The overflow from the hotwell was measured by means of two tanks, each of which was 10 ft. long by 4 ft. wide by 3 ft. deep. The overflow could be directed to either of the tanks at pleasure, and there was a sluice-valve at the bottom of each tank for emptying. Thus one tank could be filled while the

other was being emptied, and *vice versa*. The tanks were covered over at the top, but a liberal-sized manhole was made in each cover, as well as a number of smaller holes for allowing the air to escape as the water rose in the tanks. The overflow from the hotwell was allowed to pour into the tanks until the water commenced to rise in the manhole, so that the tanks were filled each time. As the sluice-valves were of ample area, the emptying tank was discharged some time before the other tank was full. The arrangement worked very satisfactorily. The average time of filling one of the tanks was about six minutes, so that it gave ample opportunity for making observations, and there was no undue haste. The tanks were within 8 ft. of the air-pump, and the temperature of the overflow was taken on its entering into the tank at each time of filling.

(For the result of the boiler-trials see Table I, Page 220.)

Table II., Page 220, sets forth the performance of the engine in a summarised table, with regard to which it should be explained, that in column 15 the consumption of coal is calculated from the water consumed by the engine per I. H. P per hour, and on the basis of 9 lb. of water evaporated by 1 lb. of coal. The actual consumption of coal on the trials per I. H. P. per hour was effected by the conditions under which the boilers were worked, as already explained while treating of their evaporative efficiency. Such conditions are quite independent of the engine, so that the calculations with regard to the engine should not be complicated by them. An evaporative efficiency of 9 lb. of water to 1 lb. of coal was taken on the authority of Mr. Masson, acting on behalf of Messrs. Bertram, makers of the engine, who informed me that that formed the basis of their contract, as to the economic working of the engine.

Proceeding on this basis, we find that the coal consumed per I. H. P. per hour by Messrs. Bertram's engine was in trial No. 1, 2·794 lb.; and in trial No. 2, 2·561 lb. We shall, I think, be satisfied in taking the better of these results—viz., that obtained in trial No. 2, inasmuch as there was a little loss of water by blowing off the safety-valve of the economiser in the case of trial No. 1, while the calculations on the units of heats passed off from the engine confirmed the view that some loss had arisen in the case of that trial. We may therefore take the consumption of Messrs. Bertram's engine to be 2·56 lb. of coal per I. H. P. per hour, based on the evaporation of 9 lb. of water to 1 lb. of coal.

On referring to column No. 13, the number of units of heat will be found which were passed off by the engine to waste through the hotwell, as well as through the steam-jacket, per I. H. P. per minute. It will be seen that in the experiments 1 and 2, the number of the units of heat carried off to waste was less than in experiments 3, 4, and 5, the pressure of steam being greater in 1 and 2 than in 3, 4, and 5; also that the number of units of heat carried off to waste in experiment No. 5, in which the steam-jacket was used, was less than in trials 3 and 4, in which the steam-jacket was not used. The superior economy when the steam-jacket was used would no doubt have been more clearly shown had the pressure of steam been higher and the cut-off earlier, and it was proposed to have another trial, to show this, but the length of time already occupied prevented this proposition being carried out. These results may be arranged as follows, for more easy comparison:—Trial No. 1, steam-jacket in use, steam pressure, 53·3 lb.; units of heat wasted, 364. Trial No. 2, steam-jacket in use, steam pressure, 52·3 lb.; units of heat wasted, 377; mean, steam-jacket in use, steam pressure, 52·8 lb.; units of heat wasted, 370·5. Trial No. 3, steam-jacket out of use, steam pressure, 34·7 lb.; units of heat wasted, 488. Trial No. 4, steam-jacket out of use, steam pressure, 31·8 lb.; units of heat wasted, 480; mean, steam-jacket out of use, steam pressure, 33·25 lb.; units of heat wasted, 484. Trial No. 5, steam-jacket in use, steam pressure, 31 lb.; units of heat wasted, 438.

The report ends by expressing Mr. Fletcher's favourable opinion of the working and capacity of this new engine. It contains many new points that will require time to be properly tested, but it appears that every experiment and observation goes to strengthen its claims on manufacturers as a cheaper and better class than we have yet obtained. The position the inspector occupies as engineer to the Manchester Steam-Users' Association, gives additional weight to his observations.

[We are enabled by the courtesy of our contemporary *The Engineer* to illustrate Messrs. Bertram's engine, which is the only drawings that have been taken.—ED.]

Chemistry applied to the Arts, Manufactures, etc.

ABSTRACTS FROM FOREIGN PERIODICALS, TRANSACTIONS OF SOCIETIES, ETC.

Alum.—A recent invention for the production of alum consists in treating shale by adding the requisite quantity of acid at once to a charge of the shale, and subsequently transferring it successively to other charges. Thus three vessels are used to which shale is supplied, and to the first is added the whole quantity of acid to constitute an equivalent for all the alumina and other bases to be extracted from a full charge. After this has been boiled for a sufficient time the solution is removed, and transferred to the second vessel containing shale, and after digestion to the third vessel, and after digestion therein the liquor is run off for the manufacture of alum. The first vessel having been emptied is again filled, and the second of the series has now a full charge of acid boiled upon the shale therein, the solution being then transferred to the vessel from which the finished liquor has been run. After boiling here it is transferred to the refilled vessel which now becomes the third of the series, and thus the process goes on, the pan which has been for digestion with the fresh charge of acid being the one to be emptied and refilled. Thus the fresh acid is digested upon partially exhausted shale, and extracts as much as possible of its alumina, while the partially saturated acid is digested upon the fresh shale, and is thus all, or nearly all, taken up. Sometimes two instead of three vessels may be employed, or if the solution is desired to be entirely neutral or "sweet," then if it should prove necessary more than three may be used. In like manner the series of digestions may be used for the production of the ordinary and basic alumino-ferric compounds from bauxite or shale, or from both.

Chemical Inks.—The *Deutsche Illustriate Gewerbezeitung* proposes the general use of what may be called postal-card ink, for messages which are sent on such cards or otherwise unsealed. A solution of nitrate or chloride of cobalt, or chloride of copper, mixed with a little gum or sugar, produces a "magic ink," which is made visible by warming, either by holding against the stove or over a burning match. Potassium ferrocyanide in solution may also be used; but this requires a developer for which either copper or iron sulphate may be employed. With the former the writing will appear in brown and with the latter in blue colour. If these inks are used, probably many cards will be posted without apparent address.

Petroleum Stink.—M. Mason, of Lyons, has succeeded in removing the disagreeable odour of petroleum by the following process:—Into a vessel containing 225 lb. of petroleum, are separately introduced, by means of a funnel, 2 oz each of sulphuric and nitric acid, and 11·1 lb. of stronger alcohol are carefully poured upon the surface of the petroleum. The alcohol gradually sinks to the bottom, and when coming in contact with the acids heat is developed, and some effervescence takes place, but not in proportion to the quantity of the liquids. Ethereal products of a very agreeable odour are formed, and the substances thus treated acquire an analogous odour, at the same time becoming yellowish in colour. The operation lasts about an hour, after which the liquids are thoroughly agitated for some minutes with water, and after resting for eight or ten hours the purified petroleum is drawn off. The lower stratum, which is a mixture of the acids, water, and alcohol, may be used for deodorising the heavy oils of petroleum, by agitating them well for twenty minutes, and after twelve hours, washing the oil twice with milk of lime, to remove the free acids. It will then have the same but a weaker odour as the light petroleum first treated, and answers well for lubricating purposes. Petroleum thus purified may be used in pharmacy for many purposes. All the tinctures for external use may be prepared with it, like the tincture of arnica, alkanet, and camphor. It may be used for dissolving ether and chloroform like alcohol, and, combined with fats or glycerine, promises to be of great utility in the treatment of skin diseases, &c. The alcohol used in pharmacy might be replaced by this purified petroleum.

Waterproof Paper.—Packing paper may be made water-tight by dissolving 1·82 lb. of white soap in one quart of

water, and dissolving in another quart 1·82 oz.—apothecaries' weight—of gum arabic, and 5·5 oz. of glue. The two solutions are to be mixed and warmed, the paper soaked in the mixture, and passed between rollers or hung up to dry.

Natural Deposit of Bin-oxide of Manganese.—The *Ztschr. fur H. G. u. V.* reports the discovery of a rich deposit of pyrolusite (the bin-oxide of manganese), in the immediate vicinity of the Upper Silesian iron industry. The ore is said to contain 63 per cent. of manganese. The bed at the place where it was first discovered has a thickness of 3 metres; besides, the mineral is said to permeate the rocks which lie adjacent to the bed proper. The ore is of such quality and possesses such properties that it can be put to many industrial uses, as for the manufacture of chlorine, chloride of lime (or bleaching powder), glass, paper, &c., but principally for the production of ferro-manganese.

Lead Poisoning.—Workmen employed in the manufacture of white lead are always liable to lead poisoning, both by inhaling the dust and in touching the lead with the hands. Various correctives for this have been employed, and among these the latest and most simple is a careful washing of the hands in petroleum. Three washings a day are reported to be sufficient to prevent all serious danger of poisoning. The benzole in the petroleum is said to scour the skin and remove the dust of lead, and the fatty substance in the oil prevents the absorption of the lead salts. The experiments made in petroleum used in this manner give such good results that it is proposed to use the same material as a guard against poisoning in other industries where the salts of copper or mercury are employed.

Warming Buildings by Hot-Water.—The circulation of hot water through very large buildings and the softening of water have been subjects especially experimented on in the new buildings erected on Banstead Downs in Surrey for the accommodation of patients chargeable to the County of Middlesex on account of lunacy. It involves hypotheses which are likely to be controverted, but as they are undergoing the testing process time will demonstrate their value. Meantime whether successful or not, the construction has been placed in good hands and under the guidance of those who desire to know what is true and right in this speculative department.

Mr. Brampnell, F.R.S., the engineer appointed by the Middlesex magistrates, reports that "this asylum extended over many acres, comprising numerous separate 'blocks,' for the reception of the patients, for infirmaries, the administration department and other purposes. In order to obtain economy and simplicity in management, it was desirable that the whole of this extensive acreage of buildings should be heated and supplied with hot water for baths and other purposes from one source of heat. In a single house, or even in a single large building, the circulation of hot water could be automatically maintained by the mere difference in gravity between the hotter ascending column of water and the cooler and heavier descending column. The power thus obtained, was inadequate to cope with the miles of pipes at Banstead. To overcome the difficulty and to enable the building to be warmed and supplied from a single source of heat, he had devised the plan of placing in the engine-house a centrifugal pump, which forced the water along the outgoing main and exhausted it along the return main. These mains were conveyed side by side in trenches throughout the whole enormous establishment. They were not connected at their ends, but at each block of buildings a pipe, controlled by a valve, led the hot water into that block and supplied the whole of the heating coils therein, the outlet pipe from this system of coils being united to the return main. Thus the water circulates through each block with the velocity due to the difference of pressure between the outgoing and the return mains, instead of circulating with the feeble velocity arising from a mere difference in temperature. It would be seen that there was no waste of fuel in the employment of steam to work the certrifugal engine, because the waste steam of the engine was used to aid in heating the water. He proceeded to point out how this system of forced circulation would render it possible to lay on to groups of buildings, such as streets of workmen's dwellings, a supply of hot water for heating their dwellings and for washing purposes. The water was pure spring water obtained from a deep well in the chalk. This water was about 17 degrees of hardness, and was therefore a perfectly fit water for dietetic purposes in its natural condition, but on being boiled it deposited the carbonate of lime in the boilers and pipes through which it was conveyed, and thus he was led to urge upon the magistrates the necessity of preserving their boilers and heating apparatus from being coated with carbonate of lime, by softening the water by Dr. Clarke's process. This process is an extremely beautiful and simple one. The hardness of chalk waters depends principally upon their containing a certain amount of bicarbonate of lime in solution. Lime is soluble in water readily, bicarbonate of lime is soluble in water readily, but carbonate of lime is insoluble. If, therefore, the bicarbonate could be converted into a carbonate it would be deposited from the water, which would thus become soft. This conversion of the bicarbonate into a carbonate is effected in Clarke's process by mixing with the natural water containing the bicarbonate a small portion, one-tenth to an eighth, of water in which lime has been dissolved. On these waters being united they instantly became milky, and after being allowed to stand for some hours the water again becomes bright, the carbonate of lime having fallen to the bottom. This operation requires very large depositing tanks and a considerable expense in plant, but Mr. Porter has recently invented an improvement upon Clarke's process which appears to promise excellent results, and has been adopted at Banstead. The principle and mode of treatment, as far as the chemistry is concerned, are precisely the same as Dr. Clarke's, but instead of waiting the slow process of deposition to separate the carbonate of lime from the water, the mixed water is passed through filter presses of a peculiar construction, wherein the very carbonate of lime itself is made the filtering medium for itself, and in this manner within a quarter of an hour of the mixture having been made perfectly pure and soft water issued forth. There are four presses at Banstead and these are sufficient to filter an average hourly quantity of 60,000 gallons of the purest and softest water. This water is pumped into the tank on a tower 80 feet high. The tank contains 240,000 gallons. Six-inch pipes, so as to avoid friction, are laid all over the asylum, and internal and external hydrants are fitted thereto. Moreover, if a fire continued so long that the tank was exhausted the engines which draw the water from the well and raise it into the tank can be caused to act direct as fire engines."

Thermometer.—*La Nature* describes an ingenious new registering thermometer devised by M. Hervé Mangon, as a long and fine capillary tube bent on itself and containing mercury; it is supported in an iron frame; it passes through the stopper of a bell jar and terminates with a fine point in a mercury dish placed in one scale of a balance; the other scale contains a vessel of glycerine communicating by glass and india-rubber tubing with another glycerine vessel on the same level in an adjoining frame. When, on a rise of temperature, mercury is forced out into the vessel, the balance is depressed on one side and an electric contact made, affecting an electro-magnet in the registering apparatus. This is composed of M. Redier's double wheel-work with differential train. When the depression referred to has occurred, a suspended float in the second glycerine vessel descends and raises the glycerine in the first, increasing the weight in that scale. The curve obtained from a pencil on moving paper, is of zigzag form, the wheel-work being in constant motion, now to the right, now to the left.

Nitro-Glycerine.—In testing the comparative explosiveness of nitro-glycerine in the crystallised and the liquid state, Beckerheim used a dropblock of wrought iron weighing 2·130 kilogrammes, having at its lower end a hardened steel point of 7·068 square milllimetres. The nitro-glycerine was spread in a thin layer on a flat anvil, and the weight dropped from different heights. The liquor exploded at a fall of 0·78 metre, but the crystallised or frozen nitro-glycerine only when the fall was increased to 2·13 metres.

Pickling Timber.—In speaking of the well-known methods of preserving posts and wood which are partly imbedded in the earth, by charring and coating with tar, the *Ind. Blätt.* says these methods are only effective when both are applied. Should the poles only be charred without the subsequent treatment with tar, the charcoal formation on the surface would only act as an absorber of the moisture, and if anything, only hasten the decay. By applying a coating of tar without previously charring, the tar would only form a casing about the wood, nor would it penetrate to the depth which the absorbing properties of the charcoaled surface would insure. Wood that is exposed to the action of water or let into the ground should first be charred, and then before it has entirely cooled be treated with tar till the wood is thoroughly impregnated. The acetic acid and oils contained in the tar are evaporated by the heat and only the resin left behind, which penetrates the pores of the wood and forms an air-tight and waterproof envelope. It is important to impregnate the poles a little above the line of exposure, for here it is that the action of decay affects the wood first, and where the break always occurs when removed from the earth or strained in testing.